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MASSACHUSETTS: ALTERNATIVE ENERGY TECHNOLOGIES

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HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY CONSERVATION AND POWER

OF THE

COMMITTEE ON
ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

FIRST SESSION

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MASSACHUSETTS: ALTERNATIVE ENERGY TECHNOLOGIES

MONDAY, OCTOBER 21, 1985

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ENERGY AND COMMERCE,
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER,
Boston, MA.

The subcommittee met, pursuant to notice, at 9:16 a.m., in Faneuil Hall, Boston, MA, Hon. Edward J. Markey (chairman) presiding.

Mr. MARKEY. Good morning. I welcome you all to this field hearing of the House Subcommittee on Energy Conservation and Power, which we have convened in honor of Massachusetts Energy Awareness Week. I especially welcome my distinguished congressional colleague, Jerry Sikorski, from the State of Minnesota, a loyal and valued member of the subcommittee, and my friend Michael Dukakis, the great Governor of the Commonwealth, who has ensured that energy awareness is a year-round activity and not just an annual formality.

Communication problems are often endemic to Washington, reminding me of the story about the woman who consulted a divorce attorney for legal assistance. The lawyer's first question was whether the woman had grounds for divorce. She replied, "Yes, as a matter of fact, about an acre and a half." Undeterred, the lawyer asked whether the woman had a grudge. She replied, "No, I do not have a garage, but I do have a double carport." Growing uneasy, the lawyer asked whether the woman's husband beat her up. She replied, "No, generally I get up earlier than he does." Exasperated, the lawyer finally asked, "Are you sure you really want a divorce?" The woman responded, "No, actually I don't want a divorce at all. It's my husband who wants a divorce. He contends that we're having difficulty communicating."

Well, I am happy to say that we don't have that kind of communication problem here in Massachusetts with Washington and its congressional delegation. Indeed, the subcommittee strives to maintain an open communication line between the thriving alternative energy industry in the Commonwealth and the Capital City of this country. Alternative energy technologies, energy efficiency, and conservation are, indeed, alive in Massachusetts. Some of this is attributable to the harsher necessities of the New England experience, in particular our notoriously fierce winters. With the costs of energy as high as they are, energy conservation and efficiency are matters of necessity and not choice.

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But there is more to the picture than geography. The Commonwealth is both a laboratory of innovation and a center of intelligent governance. The formidable educational institutions, adventurous entrepreneurs, and savvy legislators of Massachusetts have catalyzed the vast potential to divert the region's resources away from energy business as usual and into the vanguard of the Nation's energy future.

All of this is transpiring in a Federal environment that is wholly antithetical to this spirit of economic prudence and entrepreneurial adventurousness. In Washington, the Reagan administration's Department of Energy is continuing its assault on the alternative energy industry. While nuclear fusion and fission continue to occupy center stage in the DOE energy technologies budget, consuming together nearly two-thirds of the administration's most recent budget request, energy conservation occupies only 17 percent, fossil energy only 12 percent, and solar energy only 8 percent of the total.

As another example, the Reagan administration's most recent tax reform proposal would eliminate the conservation and solar energy tax credits while preserving massive tax subsidies to the oil and gas industries. In the meantime, DOE never misses an opportunity to put in its 2 cents' worth in favor of the nuclear power industry, whose difficulties DOE now seeks to blame on the regulators and legislators of Washington.

The Energy Conservation and Power Subcommittee is charged with the task of formulating a national energy policy, not of bailing out favorite industries within the energy matrix. The recent explosion of cogeneration and other alternative energy sources has added a rich new host of colors to the Nation's energy palette. This comes, in addition, at a time when the construction of traditional central powerplants has become an act of extraordinary economic risk and forecasting guesswork.

We should not again be put to the test of muddling through another energy crisis in order to lay the foundation for a rational energy mix. The current respite from crisis is not the time to return to familiar, archaic forms of power production. We look instead to innovative States and utilities to chart the new course for development.

Massachusetts should be doubly proud of its achievements in light of the fact that it has been compelled to swim against the stream. But Massachusetts' prudent investment is already paying off. In photovoltaics, for example, Massachusetts now leads the Nation, thanks to an innovative and high visibility State-level initiative sparked by Governor Dukakis' well-justified fascination with the possibilities this fledgling technology promises.

But Massachusetts' commitment to a diversified energy future is visible everywhere. The Commonwealth is in the vanguard in the areas of cogeneration and conservation. The Massachusetts Department of Public Utilities has initiated shared savings pilot programs which should serve as a model for the Nation. New England Electric's NEESPLAN is a model of least-cost planning. Boston Edison's innovative efforts in electric supply and demand management are equally commendable, and Joe Kennedy's Citizen Energy Corp.

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continues to be the paradigm of what an energy service company providing low-cost energy to lower income families can accomplish.

Most importantly, Massachusetts is a modern mecca of energy technology. As the impressive witness list and even more impressive hardware on this stage demonstrate, the Commonwealth is awash in alternatives to energy business as usual.

We can and will continue to call the Reagan Department of Energy to task for its misguided sense of priorities. Today we pause all too briefly from that fight for a day of celebration. It is good to be home, and it is even better to know that home is as enlightened an energy environment as it is.

That concludes my opening statement. I will now recognize the gentleman from Minnesota, who serves as a member of the subcommittee and also is one of the leading voices in Washington for progressive alternative energy programs for this country, Mr. Sikorski.

Mr. SIKORSKI. Thank you, Mr. Chairman. I thank you for inviting me to this beautiful State. Fall in New England beats hands down Paris in the springtime. I would also like to thank you for coming up to Minnesota last week to examine the Department of Energy's nuclear waste siting process.

Unfortunately, Minnesota was a little cold. We were in full autumn as you were there last week. With autumn comes the realization that our fuel bills will be higher and our nights will be longer and darker. You know what I'm talking about. You had 40 degrees here this morning, I think, on a beautiful, crisp autumn morning.

Along with Massachusetts, Minnesota has sought to find more efficient ways of using energy. We have one of the most progressive source-separation recycling campaigns in the Nation, saving millions of dollars in previously wasted energy annually. Our utilities have been in the forefront of new coal burning technology and have built several refuse-derived fuel plants. We tried in even the smallest ways, such as using more efficient light bulbs and turning down the heat and skyways and enclosed walkways.

I command you, congratulate you and your great leader and Governor, Governor Dukakis, your people and your industries, for realizing that energy conservation and efficiency and awareness have to be a way of life, not just an afterthought. After all, our national security, our economy, and more importantly, our children's future, depends on our judicious use of our finite resources. Peter Drucker has said the only means of conservation is innovative. You and your people and your State have shown the wealth of that idea in your battle against the dark and the cold and the harsh elements of our planet.

In a universe that stretches across 13 trillion light years—at least, that's as far as we know it reaches out—there is, as far as we know, just a narrow band on this single planet where humans can live without shelter or large fuel sources and extensive clothing. Your actions are at the frontier of human survival in that large picture.

I thank you.

Mr. MARKEY. Thank you very much. That concludes opening statements by members of the subcommittee.

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We now turn to our first witness and recognize the Governor of our Commonwealth, a man who I began serving with in 1974 as a State legislator as he was just assuming the job of chief executive of the Commonwealth, but someone who right from that moment, which was essentially the beginning of the first energy crisis in this country, has given the kind of leadership and visionary foresight to the kinds of changes in policies which will be necessary for not only this region but this country as well to become less dependent upon imported sources of energy.

We recognize and welcome the Governor of the Commonwealth, Michael Dukakis.

STATEMENT OF HON. MICHAEL S. DUKAKIS, GOVERNOR, COMMONWEALTH OF MASSACHUSETTS

Governor DUKAKIS. Thanks, Ed, very much, and thank you all. I am particularly grateful to you for inviting Congressman Sikorski to join you. He is somebody who we have admired and respected for a long time, and particularly for his leadership on the acid rain issue. I hope that we are beginning, slowly but surely, to make progress toward a national framework for dealing with that problem, which I know you are deeply concerned about, and we are too, which vitally affects your State and ours and the entire Nation. We're grateful to you for all you have done on that.

I am delighted you have come to Massachusetts. Here, in a State which is creating the future in so many ways, we view energy efficiency and the development of alternative energy resources as our single most important energy priority.

We recognize that to create a future in which there is genuine economic opportunity for all our citizens and a clean and safe environment for this and future generation to enjoy, we must lead the way in providing secure, renewable, inexpensive, and safe sources of energy. And that is exactly what we are doing.

The map to my right and your left tells part of the story of our success. Over two dozen of these symbols represent active operating alternative energy facilities. Each one of them stands as testimony to the bright promise of alternative energy. Each one of them has taken us one step further from our dependence on foreign oil. Each one of them has helped reduce our energy costs and thereby increased our economic competitiveness. Each one of them has allowed us to manage our natural resources so that future generations will have the opportunity to enjoy them and not to bemoan their loss.

Let me tell you about some of these projects. Just across Boston Harbor in the town of Hull, the town, with State assistance, has constructed the largest wind energy system in the Commonwealth to provide power to that community's high school, a system that has reduced the town's energy costs by approximately $7,500 a year.

Just a short subway ride from here swimmers at the University of Massachusetts Boston's olympic-sized swimming pool will enjoy the comfort of water heated by geothermal energy from the ground on which the institution stands.

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Twenty-nine elderly housing projects across the Commonwealth, with more than 300 residents, have benefited from the lower costs of passively heated solar buildings.

This Thursday we will be adding another symbol to our map and another chapter to our story when Sharon Pollard, our Secretary of Energy, will help place the first photovoltaics solar panel on the city hall in Gardner, MA—the culmination of an effort between State government, a local photovoltaics manufacturer, and one of our largest utilities to stimulate the rebirth of that proud old mill city with the application of a home-grown modern technology. Thursday marks the beginning of our effort in Gardner, but it is just a beginning. When we are finished, nearly 30 public and private residences and businesses in that community will be powered by photovoltaics cells.

These stories and the many others on the map to my right hold great promise for our future, but they represent only part of our story. For one of the most interesting chapters to our energy story is just now being written. It's authors are Roger Little, John Fan, Bill Hogan, Byron Battle, and your colleague, Chet Atkins, Secretary Pollard, and Bob Hammond—pubiic officials, CEO's and marketing directors from the private sector, and a university president, all dedicated to encouraging the development of photovoltaics technology and its commercial application. They are the newly appointed directors of the Massachusetts Photovoltaics Center of Excellence, one of five centers of excellence in Massachusetts, places where the collaborative efforts of private industry, educational, and research institutions and State government are shaping the technologies of the future.

What is the Photovoltaics Center of Excellence and what will it be doing? First, it will expand our world class research and development efforts in photovoltaics technology; second, it will aggressively market Massachusetts photovoltaics in the international economy. That effort will include a new trade and marketing center at Logan International Airport, operated by the center with State resources. Third, working with the University of Lowell, one of our regional State universities, it will offer technical and training services to our photovoltaics customers. And fourth, it will assist new and expanding photovoltaic companies to invest and expand their R&D and manufacturing operations in Massachusetts.

The fruits of this partnership are already being harvested. John Fan and his Kopin Corp. just this month have embarked on an ambitious research and development venture in Taunton where Dr. Fan and his colleagues will chart new territory in PV technology and create, we expect, hundreds of jobs for that region's workforce.

Taunton, Congressman Sikorski, incidentally, is located in a region of Massachusetts which, until recently, had been one of our most chronically depressed regions and is today enjoying an economic renaissance as a result of aggressive and targeted State efforts to bring new economic vitality to southeastern Massachusetts, including this new photovoltaic venture.

We are now, however, putting all of our energy eggs into the photovoltaic basket. Four waste to energy plants, one of them in Congressman Markey's district, will be open and operating by the

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end of the year. There are three more currently on the drawing board which are moving toward the construction phase.

Out in western Massachusetts this Friday, Secretary Pollard will join the people of Holyoke in dedicating a new hydroelectric facility that is the product of a partnership between the city, the Commonwealth, and one of Holyoke's local utilities.

These are exciting stories. They offer bright promise for this State's economy and for our quality of life. They offer us an opportunity to create the future, a future of reliable, safe, and competitively priced energy.

Unfortunately, we see another and much less promising story in the Nation's capital. We have seen the national commitment to solar research and development virtually decimated in the past 4 years. We see a Federal Energy Department which spends 42 times more on defense research than it does on alternative energy research. We see a set of energy priorities that charts a very different course for this Nation than the one we are attempting to steer in this Commonwealth.

The role of this committee in establishing a new direction for this country's energy policy, and with it a brighter, safer, and more secure future for our Nation, is a critical one. We are proud of the Commonwealth's success and we are delighted to be able to share it with you. We expect that you will be able to share with us experiences that are taking place in other States which are equally as promising. We are very, very pleased to have you here in Boston and to be able to share our work and our experience and our hopes with all of you.

I have two of my best energy people with me, who you know very well, Congressman. While I have to go out to Southeastern Massachusetts University to break ground for the new SMU Science Building after 7 years of effort, they will be around for a while and will be happy to join you.

If you do have any questions for me personally, I would be happy to respond.

Mr. MARKEY. If I may—and I know you do have to leave—but could we just ask if you could give us your general impressions of the Reagan energy policy; that is, the attitude toward renewables and alternative energy resources as opposed to the policies that are embodied in his new tax proposal and, in general, his Department of Energy's——

Governor DUKAKIS. I think there is a basic view of this problem which, if the President were here today, I think he would agree with this interpretation, which essentially is one which says the market can do these things and if the Federal Government has any appropriate role at all, it is in defense-related kinds of research and development and investment.

Now, I don't know of anyone here who doesn't think that the Federal Government ought to devote some resources to the defense side of the energy picture. In fact, I would suspect, without knowing in detail, that at least some of those investments on the defense side will bear fruit in terms of nondefense applications.

But we have a very short memory, Congressman, in this country. Things move very fast. We have difficulty 6 months after an event remembering just exactly what happened 6 months previously. And

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for those of us—and there were many of us who were here back in 1973, 1974, and 1975—those memories are not going to fade. I think most of our success in this country at weaning ourselves away from too much dependency on foreign oil has a great deal to do with what so many of you did back in the late seventies to get Federal funds and Federal resources into investments in alternative energy, and we tried very hard to be full partners with you in that effort. But I can't think of anything more shortsighted, particularly in a policy area where frankly we have always assumed that something more than the market was necessary—we regulate utilities, they expect that, though obviously we and they hope it will be enlightened and thoughtful regulation—but in the area where public involvement has always been assumed—and I'm not suggesting we shouldn't encourage the market because the market has had a lot to do with what has been happening here—I just think that our failure to invest in these technologies is very shortsighted and may be penny wise but pound foolish.

When we see so many exciting things happening here and across the Nation, I can tell you that some modest, thoughtful, reasonable, well-focused Federal investments in what we're doing would be extremely helpful. I do not, however, mean to suggest for 1 minute the States don't have a major responsibility. As you know, from what we're doing in this State, we take that responsibility very seriously. But it has got to be a joint effort, Federal and State, with the active involvement of the private sector, and we think here in Massachusetts, although we certainly have concerns about our energy future which we are addressing, that much of what we have done is a good model.

Mr. MARKEY. My time has expired.

The gentleman from Minnesota.

Mr. SIKORSKI. I thank the chairman and thank the Governor.

We are moving on acid rain. Again, it's the same problem. The administration is reluctant to do anything except study more and more and more and more. But there is——

Governor DUKAKIS. Mr. Lewis gave us some hope in Springfield the other day, Congressman.

Mr. SIKORSKI. That's right. He said that to deny the relationship between acid rain, or sulphur dioxides and acid rain, is like denying the relationship between smoking and lung cancer. Hopefully, that's a harbinger of good news on that. But we're going to move nonetheless.

But there is a tie-in, a direct tie-in. Every day over the North American continent we shoot 176,000 tons of this acid into the sky——

Governor DUKAKIS. That's right.

Mr. SIKORSKI [continuing]. Most of it because of electrical generation and coal-fired plants. And for every hydroelectric facility we have put in place, a chain of lakes is being saved in this continent, and for every solar cell, every alternative renewable energy source that is used, we are saving trees and lakes and our economy. And for every act of conservation or conserving our resources, using less of that coal-fired electricity, we are saving lungs and saving monuments like the Statue of Liberty from being harmed. So there is a direct relationship and that is why this is exciting, not only from

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the numbers, the dollars, and from a strict energy sense, but from an environmental sense as well. I congratulate you.

Governor DUKAKIS. Well, we not only agree with you, but one of the reasons that we're putting so much time and attention into photovoltaics among other alternative energy sources is because it seems to us that in that technology, if we can develop it and make it increasingly cost competitive, we have almost the perfect answer to both environmental and energy problems. It is environmentally benign and it's one of those things which has incredible potential. We are just very fortunate in Massachusetts to have over half of the domestic photovoltaic industry and it is one of the reasons why we're now putting direct State resources into it.

But, in the meantime, again I want to commend you for your efforts on the acid rain issue and to tell you what you already know, which is that we are very, very anxious to work with you and Congressman Waxman and everybody, both in the House and Senate side, to see if we can finally break through on that one and begin to do what we should have done a long time ago.

Mr. SIKORSKI. Thank you.

Mr. MARKEY. Thank you, Governor. We thank you for your participation and we commend you for your leadership on this issue.

Governor DUKAKIS. Thank you. I leave you in good hands.

Mr. MARKEY. We will at this point call upon Joseph Kennedy, the president of Citizens Energy Corp., to join the panel, and then we will commence with the testimony from the second panel.

Our second panel consists of Joseph P. Kennedy, president of the Citizens Energy Corp., Boston, MA; Miss Sharon Pollard, the secretary of energy resources for the Commonwealth of Massachusetts; and Mr. Robert Keegan, commissioner of the Massachusetts Department of Public Utilities.

We will begin by hearing from the secretary of energy of the Commonwealth, Sharon Pollard. Welcome.

STATEMENTS OF SHARON M. POLLARD, SECRETARY, MASSACHUSETTS EXECUTIVE OFFICE OF ENERGY RESOURCES; JOSEPH P. KENNEDY II, PRESIDENT, CITIZENS ENERGY CORP.; AND ROBERT J. KEEGAN, COMMISSIONER, MASSACHUSETTS DEPARTMENT OF PUBLIC UTILITIES

Ms. POLLARD. Thank you, Congressman. I am delighted to be with you today. I want to commend you for your efforts to hold this hearing in Massachusetts. Today does inaugurate Massachusetts Energy Week, so we are very appreciative of your beginning our week with this hearing. I can't think of a better way to commence it.

We are also delighted that Congressman Sikorski could be with us today. Minnesota has a lot of innovative programming and a lot to offer, and we sometimes work with your people in Minnesota to "pick their brains" so to speak on some terrific ideas.

One of the primary functions of the executive office of energy resources is to promote and enhance the economic development of alternative and renewable energy resources. Although the Arab oil embargo is now a memory from the past, Governor Dukakis' administration is still concerned over the Commonwealth's dependen-

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cy on costly and unreliable imported fossil fuels. Governor Dukakis elaborated on several of the programs that the energy office has implemented to encourage and foster the development of renewable and alternative energy resources.

I would like, with your permission, to elaborate on additional policy and legislative initiatives which have been fostered by the executive office of energy resources.

In December of last year, the executive office petitioned the department of public utilities—my good friend, Bob Keegan, sitting here to my left—for a rulemaking on the PURPA law. This initiative governs electricity sales from small power producers to utilities. Small power producers utilize such projects and hydro and wind power, wood/biomass, and cogeneration technologies to burn oil and gas more efficiently.

The executive office of energy resources believes that the current regulations issued by the department of public utilities in 1981 do not satisfy the intent of the Public Utilities Regulatory Policy Act of 1978, the so-called PURPA. PURPA contains provisions designed to encourage the development of small power producers and cogenerators by requiring that utilities purchase power from such facilities at a price equal to the cost the utility would have incurred to generate the same amount of power. The goal of EOER's PURPA initiative is to revise the DPU's PURPA regulations in order to facilitate the signing of contracts between small power producers and utilities and to establish clear price signals which reflect the long-term value to Massachusetts of such facilities.

Electrical energy from small power producers and cogenerators represents an important resource for Massachusetts. The executive office of energy resources currently estimates a potential of 800–1,100 metawatts of cogeneration and small power resources. The use of renewable energy resources such as wood, wind, hydro, or solid wastes in small power projects and the efficient use of oil and gas in cogeneration facilities wil help reduce our dependence on foreign oil and defer or eliminate the need for large and costly central generating systems. The adoption of new PURPA regulations will play a major role in the further development of small power and cogeneration facilities in the Commonwealth of Massachusetts.

A second set of hearings before the department of public utilities on this issue will take place on Wednesday of this week. The executive office of energy resources hopes that final regulations will be issued by the department of public utilities some time in the first of the year.

During the past year the executive office has actively supported a variety of legislation that supports all aspects of renewable and alternative energy development. These bills are currently in various stages in the legislative process. Clearly, one of the most important issues pending before us is the extension of Massachusetts' residential renewable energy tax credits. This is the centerpiece of our legislative effort. The current solar tax credit of 35 percent is due to expire on December 31, 1985. We are supporting a bill which would extend the credit for 2 more years. These tax credits currently reimburse the purchaser of solar heating, cooling, hot water, thermal, photovoltaic, passive solar design, and wind systems 35

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percent of the cost of renewable energy home retrofits—and this is after the Federal deductions are taken.

Solar access zoning legislation is a very interesting issue being dealt with by the legislature in Massachusetts. The bill that I refer to would provide for the issuance by local cities and towns of solar energy building permits which will protect access to the Sun for residents who install solar energy units.

Simplification of hydrolicensing procedures is another issue that the legislature is dealing with and that our office is involved in. This bill would encourage the development of hydropower resources in the Commonwealth by providing for a streamlined and coordinated process for licensing and permitting of hydropower facilities, which we currently do. This particular legislation would extend this particular process for licensing to all other small power facilities. We will be reintroducing this bill in November and we think it is a good phase II of our small power cogeneration PURPA initiative.

One of the stumbling blocks for some cogenerators is the ability to access financing. The Massachusetts Legislature has recently passed a bill introduced by the executive office of energy resources which would enable the Massachusetts Industrial Finance Agency to provide financing for cogeneration and small power production projects for small commercial and industrial enterprises. Add to this list the photovoltaic initiative that the Governor spoke of earlier, as well as something that we call the Alternative Energy Property Program, which at its inception in 1979 was actually the first State project to finance in any aggressive way renewable energy projects. To date, this particular program in Massachusetts has financed and funded 116 such projects. We deal with all kinds of renewable and alternative energy technologies, certainly including hydro, wood, wind, biomass, cogeneration, and photovoltaics—added to the list recently. We are also hoping to provide some resources for trash-to-energy facilities in Massachusetts.

We would like to think that we have an aggressive program dealing with renewable and alternative energy in the Commonwealth of Massachusetts, something that the Governor is quite supportive of. Additionally, we would like to thank Congressman Markey and Congressman Sikorski for coming here to Massachusetts today and thank the chairman of the subcommittee for his interest and initiative in this particular area.

Mr. MARKEY. Thank you very much.

Our next witness is Joe Kennedy, the president of Citizens Energy Corp., somebody that has really done a lot of good work in creating innovative and very progressive ways of looking at the energy sources of our country and the way in which they are provided to consumers. We welcome you here today and we thank you for giving us your leadership in the past and for your testimony here today.

STATEMENT OF JOSEPH P. KENNEDY II

Mr. KENNEDY. Thank you very much, Mr. Chairman, Mr. Sikorski, and all the rest of you who are interested in Massachusetts energy and the future of the State in general.

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For most Americans the energy crisis is temporarily over, but not so for the poor, the elderly, and many working families across our State. While most Americans spend only 3 to 4 percent of their income to meet their home energy needs, in the Northeast, here in Massachusetts, or in Minnesota, the poor may still spend 40 to 50 percent of their income on heat alone during the winter months.

I will let one of the letters that we have received recently at Citizens Energy Corp. speak for itself. This is a letter from a woman in South Boston:

> Dear Joe: I am one of those people with three young teenagers. We have been without oil for over 2 years. I am sure you have heard the heartbreaking stories. Have you ever seen children when they are actually to the point of frostbite while existing in their own home? Well, it's an experience no loving parent should have to witness. Never mind the parent, but no such child in this country should have to experience. Please help.

Citizens Energy, a nonprofit corporation, was established in 1979 to try to meet some of those needs. Our original focus was on providing low-cost home heating oil to the poor and elderly families here in Massachusetts, and through today we have provided over 30 million gallons of home heating oil to the Commonwealth of Massachusetts at prices 30 to 40 percent below current market levels. What would have normally been our profits in the international crude oil markets were turned into heating oil discounts for poor and elderly families. The tanker which arrived in Boston Harbor earlier this month was loaded with heating oil at 55 cents per gallon.

Our delivery of low-cost heating oil eased but did not solve anybody's problem on the burden of high energy costs. Many low-income citizens of the Commonwealth lack insulation and other energy-saving measures in their homes. Citizens Conservation Corp., a nonprofit, energy service company, was established with the help of the energy office in 1981 to address this problem. CCC has sponsored millions of dollars in energy savings improvements in over 4,000 apartments, ranging from triple-deckers, to large townhouse apartment complexes, to highrise apartment towers. Typically, we invest $750 to $2,000 per apartment in capital improvements and cut energy use by 15 to 50 percent.

We have been assisted in this effort by the State office of energy resources, the executive office of communities and development, and the Massachusetts Housing Finance Agency.

Essentially, the landlord agrees to pay us for the next 5 to 7 years what his energy bill would have been without our conservation measures. We will then, No. 1, do a technical energy audit; second, based upon this audit, provide the capital to make the improvements which can then be paid for over 5 years; third, oversee the installation of all the equipment; fourth, establish a tenant education program in the building to teach people how to save energy themselves; and, fifth, provide cash rebates for energy saved above the energy targets.

Using these same principles, another subsidiary, Citizens Heat & Power, has provided conservation and energy management services to schools, hospitals, city halls, State houses, jails, courthouses, any building which serves a public purpose. Today we are actually in-

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stalling some of the new technologies which appear behind you on the stage.

Effectively, what we see here in Massachusetts is that, instead of oil wells in Texas, we see conservation wells in every building in Massachusetts, and New England, and throughout the Northern tier. It is worth noting that we can save the equivalent of a barrel of oil by investing only $10 to $15. This is less than half the current price of oil. Yet the tax system continues to favor production over conservation.

Most recently, Citizens Energy has provided low-cost natural gas to the poor, and elderly, and to consumers generally. After 2 years of sparring with the pipelines, we have established in 10 States and the District of Columbia programs which already have saved over $10 million to all customers and $2 million for the poor.

Moving cheap natural gas from producers to users has not been easy. We quickly found cheap natural gas and local utilities who wanted to buy it. But the pipelines would not move it. They were afraid that our cheap gas would displace high-priced supplies they had already purchased. The pipelines use their Government-granted transportation monopoly to protect themselves from competition in marketing where they had no monopoly. Because natural gas pipelines are not common carriers—unlike oil pipelines and railroads—they simply refuse to carry for others, including Citizens.

The problems of natural gas have been widely recognized, and the natural gas industry is now at a crossroads. Consumers have a vital stake in the outcome. With full competition, consumers stand to gain as much as $5 billion in savings in the first year alone. Congress considered these problems in 1984 but didn't act. This left the Federal Energy Regulatory Commission to make sense of this industry. Under the gutsy and knowledgeable leadership of Chairman O'Connor, FERC has met the challenge.

Within the limitations of existing law, the Commission has gone about as far as it can to get pipelines to transport cheaper gas. The Commission's new rule issued 2 weeks ago requires pipelines, if they carry for anyone else, to carry independently purchased gas on a nondiscriminatory basis. Of course, pipelines shouldn't be able to limit themselves to their own gas. But without legislation to stop these unfair business practices, the Commission has done what it can. It is now up to the Congress to support this action. This is truly a fight between Mrs. McGillicuddy versus the big pipelines and we need your help.

One part of the Commission's actions is still pending, the provisions dealing with the so-called block billing. Here the Commission has requested further comment. This is an issue of critical importance to the consumer. A study commissioned by Citizens Energy and done by Professor Leone at Harvard University indicates that consumers could save as much as $5 billion a year if block billing were adopted. The savings for users here in the Commonwealth of Massachusetts alone would be over $115 million annually—and I can get you the savings in your State as well, Congressman Sikorski.

The block-billing rule would increase competition and ensure that natural gas users get the benefits of the savings on natural gas from the older wells subject to price controls. Congress clearly

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intended that those savings go to natural gas users. Yet the pipelines, through rolled in pricing, have captured those savings to subsidize their purchases of high-priced gas.

Some of this high-priced gas was purchased at four to five times the price of natural gas in today's spot market. While some of the prices have been negotiated downward, others remain at twice the competitive level. Block billing will take away the subsidy which allows these excessive prices to continue and will ensure that consumers, not high-priced producers, will get the savings.

In looking at the sweep of energy issues before this State and before this country, I can see no greater potential for both immediate and longrun savings than those offered by the Federal Energy Regulatory Commission's initiatives. I urge you and other consuming State representatives to block off the efforts of Senator Nickles and others to cut off even the funds to ink the Commission's proposed rule. This is a battle which consumers can and should win if they get the leadership they deserve.

Thank you, Mr. Chairman, and Mr. Sikorski, and all the rest of you for listening to this point.

Mr. MARKEY. Thank you very much.

Our final witness on this panel is a longtime friend of mine, someone I went to law school with, someone who headed up Frank Bellotti's office on utilities and is now a commissioner of the department of public utilities here in Massachusetts, Mr. Robert Keegan.

STATEMENT OF ROBERT J. KEEGAN

Mr. KEEGAN. Thank you, Representative Markey.

The title of today's program, "Massachusetts Energy: Innovative Models for the Nation," I think is particularly appropriate because, under the administration of Governor Dukakis, Massachusetts has taken a lead in developing innovative programs for meeting our current and future energy needs.

I would like to thank you very much, Representative Markey, and also Representative Sikorski, and the rest of the subcommittee for holding this hearing in Boston and providing us with the opportunity to outline briefly some of the programs we have undertaken.

Governor Dukakis and Joe Kennedy have briefly outlined and indicated some of the energy resources which our energy future will be based upon and built upon. Secretary Pollard has discussed a number of the important initiatives taken by the Massachusetts Executive Office of Energy Resources. I will focus my comments on measures which the Massachusetts Department of Public Utilities has taken with regard to regulated public utility companies to ensure that opportunities for energy efficiency, technological innovation and conservation are maximized.

Let me begin with the following observation: In recent years the electric utility industry has changed from a decreasing-cost industry, in which every additional powerplant built lowered the average cost of electricity, to one of an increasing-cost industry, in which every additional powerplant built increases the cost of electricity. This fundamental change requires a reassessment of tradi-

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tional regulatory policies in an effort to identify and modify those which are incompatible with the new cost structure of the industry.

A principal objective of this reassessment must be the development of a regulatory framework which allows alternative energy sources to compete fairly for that portion of the energy supply market which they are economically entitled to.

I would briefly like to mention three specific measures taken by the Massachusetts Department of Public Utilities in recent years which are designed to achieve this objective. They relate to marginal cost-pricing initiatives for retail utility sales, pricing initiatives for sales from cogenerators and small power producers to electric utilities, and the development of shared-savings conservation programs, which you earlier mentioned.

Retail pricing of both electric and gas utility sales continues in most parts of the country to be based on average-cost principles. The cost of providing these services, however, can vary significantly, depending on the time of use—time of use both seasonally and daily—and average cost-pricing principles do not reflect these timing cost differences. The result is that at certain times utility companies earn substantially more than their cost of production while at other times their prices fail to generate sufficient revenues to cover the cost of production.

Aside from the imortant implications of this type of pricing on utility company operations and earnings, average cost prices send inappropriate signals to consumers, causing them to act in ways which do not result in the economic or efficient allocation of resources. The result is that alternative energy sources involving conservation, load management, cogeneraton, and small power production which are competitive on a production-cost basis with electric and gas sales during peak use periods and which could help to reduce the high cost of production during these periods are precluded from taking their appropriate economic place in the market.

Time-differentiated marginal cost pricing of utility services results in price signals which more accurately reflect the real cost of production and, accordingly, place utility services in their proper economic position relative to competing alternatives. In the past 3 years Massachusetts has aggressively sought to implement marginal cost-pricing principles which, if followed throughout the Nation, would provide additional appropriate economic support for the development of alternative energy supply industries.

With regard to the second initiative, cogeneration and small power production, in addition to providing customers with economic alternatives to utility generation, also have significant potential as supply sources from which utilities can purchase power and resell it to their customers. Purchasing utilities, however, represent a monopolistic market which has inhibited cogenerators and small power producers from penetrating the utility supply market to the degree which would be economic. While the mandatory purchase requirements and the avoided cost-pricing principles established in the Public Utilities Regulatory Policies Act of 1978 have gone a long way toward allowing cogenerators and small power producers to penetrate this market, additional measures are necessary.

As an aside, I would agree with Secretary Pollard in her earlier comments, that the pricing formula mechanism established by the

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Department back in 1981 does not provide sufficient or truly economic incentives for cogeneration and small power production. The Energy Office did, in fact, file a innovative petition designed to revamp and reconstitute those regulations and the Department is well in the process of implementing many of those regulations, which I think will create a more positive atmosphere in the future for small power production and cogeneration.

Regulatory policies in most States continue to provide, however, economic incentives to utilities to invest in building their own sources of generation rather than purchasing power from alternative suppliers. Such incentives, which bias the generation planning process of utilities, must be removed before cogeneration and small power production reach their full economic potential. Massachusetts has recently acted to modify its regulatory policies by establishing rules which will apply similar cost-recovery principles to both new utility-owned generation sources and supplies purchased from cogenerators and small power producers. Such regulatory changes are an important step in ensuring that utilities follow a least-cost supply procurement strategy given the new cost structure of the industry.

The final initiative I would like to discuss concerns shared-savings conservation programs which the Massachusetts Department of Public Utilities has been requiring utilities in its jurisdiction to develop, and in which Joe Kennedy's organization, Citizens Conservation, has participated very aggressively and fully and innovatively in these types of programs. These programs are designed to increase the efficiency with which we use our energy supplies in the Commonwealth. In the past, utilities have devised and implemented conservation programs that produced either no documented savings or savings at such a high cost that ratepayers were made worse off than they would have been without such programs.

In response, the department has required utilities to develop cost-effective conservation programs based on the premise that a kilowatt-hour which a utility does not have to generate has the same economic value as a kilowatt-hour which it is required to produce. Under these programs utility companies are mandated to request proposals from energy conservation contractors which provide for the utility to pay, up to its marginal cost of production, for documented energy savings obtained from installing conservation measures in consumers' homes and businesses.

Most of the pilot programs currently being introduced pursuant to this initiative provide for these payments to be split between the contractor and the customer, thus providing the customer with the incentive to optimize the conservation potential of any installed conservation measures. Preliminary results indicate that in addition to having the potential to achieve significant capacity and energy savings, this type of program also provides appropriate economic support to the developing energy conservation industry.

The combination of these three initiatives in retail pricing, wholesale pricing, and conservation programs represents the movement to a regulatory framework which requires utilities to adopt integrated supply and demand planning strategies. All three initiatives are designed to promote and encourage competition in those areas of the utility industry where competition not only is possible

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but also has the promise of providing significant benefits to both ratepayers and the general economy of Massachusetts.

In a region of the country still dependent on imported foreign oil for approximately 60 percent of its energy needs, strong measures are required to promote the development and economic use of alternative energy sources which will enable us to further diversify our energy mix. In Massachusetts, I believe we have come a long way in developing such measures, and in doing so have truly become a model of innovation for the Nation.

Thank you very much for the opportunity to address the committee.

Mr. MARKEY. Thank you very, very much for your testimony.

Let me begin by asking Mr. Kennedy a question, and that is your view of the potential that exists in the use of shared savings agreements in multifamily homes as a mechanism for contributing to the overall conservation effort in the country.

Mr. KENNEDY. Mr. Chairman, one of our particular companies deals with shared savings in mutlifamily complexes. We have been able to document that in those particular residences we are able to save energy at roughly half the price of the cost of finding a new barrel of oil. The greatest frustration, I think, of the experience has been the fact that it would seem that the country ought to have a policy where we just are interested in supplying the cheapest possible energy. It often seems that energy is a very complex issue, but, in fact, it seems pretty simple to me, which is cheaper is better, as long as it's safe.

What we have in energy conservation is the cheapest form of energy, and yet we also have a tax system in our country which tends to assist a much more expensive form of energy, which is finding new barrels of oil. So as Bob Keegan from the DPU just indicated, and Steve Sweeney and NEES and other representatives here from the utilities can document, conservation energy is, in fact, cheaper in many cases than finding new sources of bringing in production. So, to me, it really is a situation where we can take the old slogan about "Drive 70, Freeze a Yankee." What we ought to be doing is view every building up here as an oil well. You can use the exact same types of write-downs that the oil industry gets. If you ever gave them to us, my God, we could just go out and drop this country's energy use by such a significant amount we wouldn't need OPEC. I mean, we would destroy them all.

So I just see tremendous potential out there. Every building has savings that can be generated and passed along to people that need it. So the answer to your question is, my God, let's just get to work and get that Tax Code straightened out so we can make the investments.

Mr. MARKEY. President Reagan is trying to straighten it out right now.

Mr. KENNEDY. Well, I figured you fellows are here to solve that today.

Mr. MARKEY. Could you describe for us some of your recent efforts to embark on electric power transmission, and what technological regulatory obstacles you have run into in trying to efficiently transmit the electricity from the Midwest surplus regions of the country to other regions of the country such as New England.

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Mr. KENNEDY. Well, that really has to do with just the fact that some of you were talking about earlier, the acid rain problem. We get hit by acid rain on both ends of the spectrum, which is on the one hand the wind blows the sulphur dioxide our way, so we get all of the bad parts of having cheap energy.

But right now we are in negotiations in buying from utilities energy. They measure electricity—I'm sure Steve Sweeney is cringing over there, having me describe an electrical transaction. But the fact of the matter is they measure energy in something called mils. We can buy energy for about 20, 21, or 22 mils in the Midwest. Currently, the new estimates on Seabrook would be that they would come in at about 180 mils. Now, that would indicate that if it is 20 mils in the Midwest, that we ought to be able to do a little bit better than 180 here in New England. So the thought was that perhaps there was some way to move that energy. After all, if we're paying for the acid rain, we might as well get some benefit of the cheap juice.

But the fact is that the electrical lines that go from here to the Midwest are fully taken up, so we haven't been able to penetrate those lines with some of the cheaper juice that does exist. There are some other parts of the country where the transmission line problem is not so devastating and we are hopeful of putting those programs into place very shortly.

One thing that I did recognize, the other day we were at the some big company in the Midwest, American Power Systems or something like that. They were saying that in 1950 they built a 1,500-mile line in 6 months to connect a nuclear facility in Tennessee up with some other generation in Chicago. Today, it would take perhaps 10 years to build that same line. And I just saw in the paper where we signed another agreement with the Canadians.

It just seems to me that we ought to be investigating—and I don't know what the cost is—but we ought to be investigating building new lines, not just to the Canadians but to the Midwest, where we have 40 percent above the reliability council's recommendations for the approved amount of energy that those generating utilities have to have. They have 40 percent excesses. And yet we're building lines to Canada. Well, why can't we build lines in our country so that we're using our country's resources? If you want to improve that, so we're not getting acid rain, then you're talking about, instead of 20-cent energy, you're talking about 40-cent energy. But it's still a heck of a lot cheaper than $1.80.

So my firm recommendation is that we look into that and, in the meantime, we let the market get to work in the electric business and see those prices come on down.

Mr. MARKEY. Great. A great suggestion. We will do that.

My time has expired. The Chair recognize the gentleman from Minnesota.

Mr. SIKORSKI. Thank you, Mr. Chairman.

I commend all of you for your efforts. They are truly innovative and undeniably needed.

Commissioner and secretary, there are associations at your level with other States. Are you involved in regional activities that would help others in the Midwest, the Northeast, the cold weather

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States, sharing information and lobbying the Congress and the Federal bureaucracy?

Ms. POLLARD. That's a great question.

Unlike the public utility commissioners—Bob can certainly speak to that with more authority than I can—the energy directors, whatever titles people have, do not have a national network of sorts, an organization, if you would, specifically geared toward those people. Any activity that happens on a national level with networking or trying to lobby other counterparts to lobby their Members of Congress in other States happens through the National Governors Association for the most part.

There are regional organizations that people like myself do have an opportunity to network with other folks. For example, the New England Governors Conference does, in fact, have an energy committee, and we meet quite frequently. There is the Midwest-Northeast Congressional Caucus that does, in fact, provide a forum for people like myself or for people in our States that have something to offer. So there are some vehicles. Add to that CONEG, which is the Coalition of Northeast Governors, which extends the New England region to New York, Pennsylvania, and New Jersey. So there are some networks like that.

But in terms of a national network, other than the New England Governors, there really is nothing. It is a void that some people have mentioned that we ought to deal with.

There are lobbying efforts ongoing from the energy directors in various States. There are people who call each other, having a list of names that they call, on issues coming up before the Congress. I think that many of the energy directors have tried to be very aggressive in letting their Members of Congress know what their point of view on certain issues might be, or what kinds of thoughts they might have on some of the budget recommendations that are going through the Congress. Some States do it better than others, obviously. But from the energy directors' point of view, that's what exists.

Bob, you might elaborate further.

Mr. KEEGAN. Thank you.

With respect to regulated industries, there is the National Association of Regulatory Utility Commissioners that does share in and give us a source of information nationwide and does, I think, constitute a fairly aggressive legislative lobbying activity in Washington. I'm on the gas committee of the National Association of Regulatory Commissioners and we get together quite frequently and share information and attempt to identify bills or programs which can be supported.

However, it is often very difficult to get a national consensus on a lot of issues——

Mr. SIKORSKI. I was going to say, you have to be divided regionally on——

Mr. KEEGAN. Yes, there are regional differences. I guess if NARUC does not do in some areas the type of activity that you would view as successful, I would really like to hear about that and provide that kind of input to NARUC.

Mr. SIKORSKI. The common carriage issue on natural gas is an issue now, in a sense, the wheeling issue that is being hot and

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heavily debated in this very subcommittee. The chairman has taken a leadership role in that area. It would help if we had the input of utility commissioners, those who regulate the utilities across the country, especially from the cold weather States on those issues.

Mr. Kennedy, I understand that your company is expanding from its Massachusetts base into other parts of the country. Can you tell me about that and whether you're looking at some of the cold weather States, particularly Minnesota? If so, I would like to assist in that effort.

Mr. KENNEDY. We would look forward to expanding to Minnesota. Right now we're moving a tremendous amount of natural gas into some of your neighboring States, Michigan and Ohio and some of the surrounding areas.

The difficulty, as I mentioned, has been up to this time in getting the pipelines to allow our cheaper gas in. This new rule that has been established by the FERC would allow local utilities to go directly to the wellhead and purchase natural gas, which is what we've been trying to do for them for some period of time. The difficulty is that that whole rulemaking is now being put on hold. In my opinion, the reason it is being put on hold, is so the special interests in Washington, in the Congress, can then be motivated to then suggest the FERC was outside of its own jurisdiction when it made these rules and it does not conform to what Congress intended.

Well, I believe when you fellows put price controls on natural gas, it was not intended that those prices would then be utilized to subsidize high-cost producers but would, rather, be passed along to the consumers as it was in oil. If we ever could get that "block billing" rule and have those pipelines opened up, my goodness, we could bring you so much cheap gas. It's literally in the hundreds of millions of dollars in savings that are potentially available for consumers in your State.

It's coming your way in the next few weeks, and unless the Congressmen and women from the consuming States—I mean, aren't there more of you than there are from the producing areas? I mean, aren't there only about five producing States in this country that are real producing States? Can't we motivate all those Congressmen and women to stand up to them?

Mr. SIKORSKI. Unfortunately, all the producers are on the Energy and Commerce Committee.

Mr. KENNEDY. Well, that's what has to change.

Mr. SIKORSKI. When you try to get on these committees, you go around and campaign just as you campaign to get elected. We set up a steering and policy committee, which is made up of 30 members, and it meets to decide our fate. There were some 40 new Members of Congress in 1982 and some 15 senior members who wanted one of six seats on the Energy and Commerce Committee. My first steering and policy person I went to was a gentleman from Texas, who sat me down and said, "Well, what committee do you want, son?" I said, "Energy and Commerce" like everyone else. He said, "Well, let me be frank with you. I'm from Texas and I like oil, and you're from Minnesota and you don't like oil; you're going to

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vote against me every chance you get." I gulped and said, "Let me be frank. You're right."

But this is a representative democracy and I'm a Member of the House of Representatives. Everyone, from my refiners, from my hospitals and nursing homes to my constituents, all are at the end of the energy pipeline. But that's not why I wanted to be on Energy and Commerce. He ended up supporting me and he asked me that I at least be rational on oil and gas issues.

I have been rational and have supported all the reforms that you have proposed thus far.

Mr. KENNEDY. Keep it up, Congressman. Thank you very much.

Mr. SIKORSKI. Thank you.

Mr. MARKEY. I will say that Congressman Sikorski might have gulped when he was asked that question, but you can imagine how many people in the energy industry gulped when they found out I was going to become chairman of the subcommittee. So there is a balance.

But one of the real problems is that there is an administration in Washington which has a Department of Energy and has a considerable amount of clout in the formulation of these policies that unfortunately doesn't reflect, I believe, the general consumer thread that runs throughout the policies that you are now advancing. And let us not underestimate the power of a Republican-run Senate and a Republican-controlled——

Mr. KENNEDY. I don't underestimate that one. But, you know, this is one where you can get them, because the fact is what he is talking about here is the ability to have—I mean, you can find out whether or not the Reagan administration is really having the interests of just big business, or whether they are interested in a competitive free market, if it really is true that it's a competitive free market—the guy who came up with this is an oldtime Republican from New York, who comes from an investment house.

If that Chairman of the FERC said to me, look, if they are really interested in free market economics and competition, then you're going to get this rule; if they aren't and they succumb to the big power, he says he's through. But nevertheless, it is one of those bellwethers, telltales, whatever you want to call it. But I think it's one you could win on because you can call his bluff.

Mr. MARKEY. Well, the problem is that for the past 5 years there has been an inherent inconsistency in the Reagan energy policy. On the one hand it calls for a free market system, that says it believes in the marketplace determining whether or not energy resources, among other things, are, in fact, only to receive benefits or are going to survive at all. But then it implements a policy, beginning with his first Secretary of Energy, Secretary Edwards from South Carolina, and continued on in this present administration, that sets up a dual standard. If you're a favored energy resource—that is, if you're nuclear powered, if you're oil or you're gas—you get all the subsidies that you're looking for and you come into the umbilical cord of Federal aid. We put life support systems on your energy sources and we guarantee that they survive, no matter what the price structure and no matter what the marketplace might be saying.

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On the other hand, if you're a nonfavored energy source, if you're conservation, if you're hydropower, if you're renewable energy resources, all of your subsidies are going to be stripped away. We're not going to give you any aid whatsoever, and we're going to shove you out into the rough marketplace to be able to decide whether or not you can survive.

Well, that kind of dual standard has Adam Smith spinning in his grave. You can't have a free market system that has three energy resources getting all the subsidies they want and the other three winding up with absolutely nothing because, in fact, it distorts the market judgments, it distorts the kind of investment decisions that have be made on Wall Street.

All we're saying is, fundamentally, give everybody the exact same subsidy, or give nobody any subsidy.

Mr. KENNEDY. That's right.

Mr. MARKEY. My fear is that although this is another policy here that you have identified that does pick out that inherent contradiction in the Reagan policy, they have so far proved immune to embarrassment in the identification of previous biases that they have built into their policy. And although this subcommittee does not have direct jurisdiction over the issue that you're raising, our sister subcommittee, the Fossil Fuel Subcommittee, does have jurisdiction. We are right now, in fact, studying the 700-page FERC ruling with the effort of ensuring that either by congressional action or inaction it does not die.

But also, as Mr. Sikorski pointed out, we're looking at an issue in the same field, which is the issue of wheeling, which is will we, in fact, be able to construct policies that ensure that there is a free flow of cheap energy throughout society that is not, in fact, distorted by regulatory or tax policies that don't, in fact, reflect the broad public interest but, rather, narrow interest that in the short run benefit a few.

Mr. KENNEDY. We'll try to come back in a few weeks with more expertise on the wheeling issue, because that is one that has the same types of issues at hand. I guess I was just enthusiastic about trying to get that $5 billion back to the folks.

Mr. MARKEY. I understand.

Mr. KENNEDY. There is, I am sure, the equivalent number in wheeling as well.

Mr. MARKEY. There is a tremendous amount of potential benefit.

Can I ask Mr. Keegan if you would give us your view of what potential exists in the shared savings area with the experience that the Massachusetts DPU pilot projects have had.

Mr. KEEGAN. Yes, I think initially we saw Joe Kennedy and Citizens involved in these kind of programs several years ago. Based on the experience and success that they were having in achieving conservation savings in a lot of apartment buildings, we kind of developed, based on their experience, these kinds of shared savings conservation programs.

Basically, the utility company pays the contractor to go in and implement conservation measures and pays up to their marginal cost of production. If they are able to save and have to produce that electricity, it's worth it to the general body of ratepayers to pay for those conservation measures. Citizens and other contractors

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are taking a portion of those payments from the utility companies and providing that to the customers to give them an incentive to continue using those conservation measures as fully as possible.

I think Citizens has seen that there is substantial savings available, and we're starting to see that, although we are in the phase for both Boston Edison Co. and NEES under the NEESPLAN in western Massachusetts in the pilot stage of a number of these programs. But from the initial indications we are getting, we are seeing substantial conservation for prices significantly less than the company's marginal cost of production. That's a very encouraging sign.

Mr. MARKEY. Thank you.

Secretary Pollard.

Ms. POLLARD. To add to that, Congressman, you may be interested in knowing that in your own State there is an aggressive effort underway to introduce shared savings as a concept into energy conservation projects in State or publicly owned facilities. The Commonwealth of Massachusetts, which has a huge energy bill, as you can imagine, every year for many of its own buildings is now undergoing a shared-savings project, the downtown office buildings, the Massasoit Community College in Brokton, which is south of Boston, as well as trying to identify clusters of other State buildings where shared-savings has not originally been an attractive option.

In addition to that, our office is operating a shared savings project for cities and towns in Massachusetts, the typical city and town that is not an attractive item to some of the large shared-savings companies. We have been working with cities and towns to identify what the problems are in attracting shared-savings companies to come to their community and to do their buildings, some of their small townhalls, or their library, or what have you, and work with them to solve what some of the problems are that still remain. Hopefully, when we finish with this project, it will be a package that can be delivered to every other city and town in Massachusetts. So there are some aggressive efforts happening in the State.

Mr. MARKEY. You know, we have a parallel bill in the Congress to give incentives for Federal buildings and Federal facilities to be, in fact, treated in a similar fashion with regard to shared-savings programs. So we're hopeful that your program can work in concert with that to create a climate which makes it possible for us to get those kinds of programs put in place.

Ms. POLLARD. Shared savings, as I am sure Joe Kennedy could probably attest to, is becoming more of an attractive option as Federal funds under the Reagan energy policies are diminished, the schools and hospitals program and other programs like that that currently do and did to a greater degree in previous years provide funds for energy conservation projects in public buildings, or schools, or hospitals. The dollars are diminishing and people are having to look elsewhere.

Mr. MARKEY. Our subcommittee was able to get that put in the reconciliation bill which is now wending its way through Congress. We hope it will be signed into law by the President by the end of this year. I think it will make a tremendous difference in terms of

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the amount of energy which is consumed by the Federal Government as the largest consumer of energy in the country. Tremendous potential is possible.

Can I ask one final question of the Secretary, and that is, to what extent has the State been able to make up for the loss of Federal programs which have been slashed over the past 4 or 5 years in areas that were of importance to Massachusetts?

Ms. POLLARD. The Governor, as you know, has a commitment to energy and progressive energy policies, a commitment to renewable and alternative energies, as well as to conservation and other policies.

Unfortunately, the Federal Government has more money than we do. They have a broader tax base than we do. We probably are not going to be able to continue to keep up with the Federal cutbacks, when the State is having to look toward picking up lost Federal dollars on some social programs, on health programs, programs that affect the elderly and the poor in Massachusetts. The State cannot just continue to pick up lost Federal moneys for programs like this, although the Commonwealth has to date been able to supplant any lost Federal dollars.

The Commonwealth of Massachusetts has a tremendous commitment dollarwise toward its energy operation, if you would. In fact, State government funds a greater percentage of our office in Massachusetts than most other States do. I am sure there are others. But government in this State contributes a great deal of money.

We are anxiously looking toward the day when there are no more Federal moneys available for State energy conservation programs. It's tragic. Many of those Federal dollars have kept energy operations alive in many of the States throughout the country. In fact, only the largest States are able to support their own efforts. So with the demise of those Federal dollars will more than likely come the demise of effective progressive energy programming in many of the various States throughout the country. It will affect less a State like Massachusetts, although we are affected—EES, SECP. Of course, ICP is staying somewhat stable because of the efforts of people like yourself. But nonetheless, we are impacted in a most unfavorable light by those Federal cutbacks.

Mr. MARKEY. Thank you.

My time has expired. Any other questions?

We thank this panel very, very much for your testimony. You put a bright, shiny face upon what Massachusetts is doing. Although Federal policies don't oftentimes coincide with our long term objectives, I think you all have a lot to be proud of, helping to make this State really the example of what can be done and has been done in this country in the last 5 or 10 years in response to the OPEC oil cutoffs. Hopefully, the Federal policies that have been or can be implemented won't curtail your further efforts to make those improvements.

Thank you very, very much.

Ms. POLLARD. Thank you, Congressman.

Mr. MARKEY. Our next panel consists of Mr. Stephen Sweeney, the president and chief executive officer of the Boston Edison Co., and Mr. Sam Huntington, the president and chief executive officer of the New England Electric Co.

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I might note during this break that we are visited today by a group of students from Malden High School who have been here for the morning listening to the testimony. We welcome you and hope that this is a good educational experience for you. We think this is still the most important, long-term domestic issue that we have to face if we are to remain energy independent from the Middle Eastern area and to identify our indigenous resources here that will be able to provide for you and for future generations into the next century.

We now have with us two witnesses who are presidents of the utilities here in Massachusetts and New England that are considered to be amongst the leaders in the country in the development of alternative energy resources and more progressive ways of constructing an energy mix that can assure for the lowest cost and the most efficient and safe means of production for this region and for this country. We welcome you to our subcommittee. We thank you for your patience thus far and we welcome your testimony.

We will begin with Mr. Sweeney.

STATEMENTS OF STEPHEN J. SWEENEY, PRESIDENT, BOSTON EDISON; AND SAMUEL HUNTINGTON, PRESIDENT, NEW ENGLAND ELECTRIC SYSTEM

Mr. SWEENEY. Thank you, Mr. Chairman, Congressman Sikorski.

I would like to comment on the changing utility environment, the role of the public in responding to those changes, and how we are going about planning for our energy future. I would also like to note a few examples of innovative programs that we have undertaken with substantial customer input that I believe can serve as models for others.

First, let's look at the environment within which a company such as Boston Edison operates today. Our business is pervasive. Our product reaches out to all citizens. Those citizens today are demanding far more of us than they ever did before. Society is changing. We have all heard about the information society, about participatory democracy, about consumers demanding a say in corporate decisions that affect their lives. These societal changes are real, driven in part by changes in technology.

Technologies in offices are changing. So, too, are the technologies of electricity production and use. We are moving toward a more decentralized supply system based on smaller plants and more diverse fuel sources. No longer are powerplants strictly under the control of utilities. We are seeing the emergence of new technologies for producing power and new approaches in the way demand for electricity is managed and controlled.

Customers, responding to changing social priorities, are demanding greater control over their use and price of electricity. Entrepreneurs are looking at energy production and energy use as targets for new business. At the same time regulators responding to consumer pressures brought about by the high cost of large energy projects are looking for new sets of rules for the regulation and deregulation of utilities.

All of these factors coming together in the mid-1980's, particularly here in Massachusetts, mean that we are in one of the most dy-

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namic, exciting, and opportunity-filled periods in our century-long history. The existence of such opportunities is reflected here today by the presence on panels of such people as Joe Kennedy, Roger Little, George Hatsopoulos, and Paul Wormser from Mobil Solar with whom we have conducted a couple of photovoltaic projects.

The opportunities in this new environment can and should benefit our customers, our shareholders, and our employees. But it means that all of us must change some of our traditional ways of thinking and acting.

This leads me to the role of public involvement. As I noted a moment ago, the consumer is placing greater demands on us today than ever before. This should not surprise us, nor should we resist it. We should, in fact, welcome it because we are a service business. Our job is to meet consumer needs through the supply of electricity and that can best be done by reaching out and getting consumers involved. Our decisionmaking process has improved because of it. The likelihood of success is greater and our positive impact on society can be magnified even further.

Today one of our biggest challenges is to bring together the changing environment, the public, and our own expertise in a coordinated, balanced and fully integrated planning process. Historically, utilities have looked at planning as a way of determining what powerplant or what transmission line would be needed and when. Today the process is far more complex and the questions go far deeper.

Today, at Boston Edison Co., our planning department integrates forecasting with the supply and demand functions so that equal weight can be given to supply side and demand side options and the effect of one course of action can be measureed against others through the forecasts.

It is a sophisticated process. It allows us to weigh the construction of capacity against the purchase of kilowatts through conservation or load management. It is a process that allows us to project prices and measure responses under a vast array of options. It gives us far greater ability to pick and choose among many options. And perhaps most importantly, it is a process that reaches out for other viewpoints, for new ideas, and for new strategies.

That has led to a number of outreach programs that we have implemented, including community meetings, our IMPACT 2000 demonstration house, the innercity apartment complex on Symphony Road using advance load management technology, a community-based conservation program, a consumer-advisory panel, and direct discussions between consumer group leaders and our executives.

In reaching out we have found that the range of opportunities available to our customers and to us can be expanded greatly. There is no monopoly on new ideas. At the same time, we have found that differences can be addressed and usually resolved in a more constructive atmosphere. It is, in fact, the relationship that exists between a utility and its customers, regulators and elected and appointed officials that allows for innovative, problem-solving actions. I believe we have seen that in our State and we hope to see more of it in the future.

Thank you very much.

[The prepared statement of Mr. Sweeney follows:]

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TESTIMONY BY STEPHEN J. SWEENEY

BEFORE THE

HOUSE SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

ON

"MASSACHUSETTS ENERGY: INNOVATIVE MODELS FOR THE NATION"

OCTOBER 21, 1985

Thank you, Mr. Chairman. I appreciate the opportunity to appear before you today. I would like to comment on the changing utility environment, the role of the public in responding to those changes and how we are going about planning for our energy future. I would also like to note a few examples of innovative programs that we have undertaken, with substantial customer input, that I believe can serve as models for others.

First, let's look at the environment within which a company, such as Boston Edison, operates today. Our business is pervasive. Our product reaches out to all citizens. Those citizens today are demanding far more of us than they ever did before. Society is changing. We've all heard about the information society, about participatory democracy, about consumers demanding a say in corporate decisions that affect their lives. These societal changes are real, driven in part by technological change.

Technologies in the office are changing. So, too, are the technologies of electricity production and use. We are moving toward a more decentralized electricity supply system based on smaller plants and more diverse fuel sources. No longer are power plants strictly under the control of utilities. We are seeing the emergence of new technologies for producing power and new approaches in the way demand for electricity is managed and controlled.

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Customers, responding to changing social priorities, are demanding greater control over their use and price of electricity. Entrepreneurs are looking at energy production and energy use as targets of opportunity for new business. At the same time, regulators responding to consumer pressures brought about by the high cost of large energy projects are looking for new sets of rules for the regulation, and deregulation, of utilities.

All of these factors coming together in the mid-1980s, particularly here in Massachusetts, mean that we are in one of the most dynamic, exciting and opportunity-filled periods in our century-long history. The existence of such opportunities is reflected here today by the presence on panels of such people as Joe Kennedy, Roger Little, George Hatsopoulos and Paul Wormser from Mobil Solar with whom we have conducted a couple of photovoltaic projects.

The opportunities in this new environment can and should benefit our customers, our shareholders and our employees. But it means that all of us must change some of our traditional ways of thinking and acting

This leads me to the the role of public involvement. As I noted a moment ago, the consumer is placing greater demands on us today than ever before. That should not surprise us nor should we resist it. We should in fact welcome it because we are in a service business. Our job is to meet consumer needs through the supply of electricity and that can best be done by reaching out and getting the consumer involved. Our decision making process has improved because of it. The likelihood of success is greater and our positive impact on society can be magnified even further.

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Today one of our biggest challenges is to bring together the changing environment, the public and our own expertise in a coordinated, balanced and fully integrated planning process. Historically, utilities have looked at planning as a way of determining what power plant or what transmission line would be needed at what point in time. Today the process is far more complex and the questions go far deeper. Today, at Boston Edison, our planning department integrates forecasting with the supply and demand functions so that equal weight can be given to supply side and demand side options and the effect of one course of action can be measured against others through forecasts. It is a sophisticated process. It allows us to weigh the construction of capacity against the purchase of kilowatts through conservation or load management. It is a process that allows us to project prices and measure responses under a vast array of options. It gives us a far greater ability to pick and choose among many options. And, perhaps most notably, it is a process that reaches out for other viewpoints, for new ideas and for new strategies.

Finally, I would like to comment on a number of the specific activities we have undertaken to bring the public into the planning process. Some of these programs can, and already do, serve as models for others.

In 1983 we ran a series of community meetings throughout our service territory specifically to get input on fuel diversity, conservation and load management programs. Input from those meetings helped shape our conservation efforts and led to two innovative projects designed to advance technology and provide public education.

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One is the IMPACT 2000 House, the high efficiency photovoltaic home that was build over a 26 week period before a national public television audience. The other, in cooperation with Mass. Audubon, is the Symphony Road project which involves the restoration of a multi-story building in Boston. That project combines some innovative approaches to conservation and load management with an effort to improve Boston's older housing stock and stabilize inner-city neighborhoods. Both projects have been recognized by the Commonwealth of Massachusetts and the U.S. Department of Energy in their technology transfer awards programs. Both projects originated with customers.

Our proposed coal conversion in South Boston received all of its environmental permits and achieved community support largely because we listened to what the community and to what the state agencies were telling us about environmental concerns. We held community meetings, altered our plans and went back to the community. The result was a better plan. Public input, however, could not overcome the economic effects of declining oil prices which led us to suspend the project.

In September, we announced the establishment of a new residential conservation program; the direct result of input from community groups. That program combines a home energy survey with weatherization. It overcomes a major shortcoming in most audit programs by providing the incentive to take the next step which is the actual work involved in weatherization. It is a community-based program. Ten community groups, operating as a non-profit corporation under contract to Boston Edison Company, are now active partners in this unique home energy audit program.

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In 1984, I, and nine other officers, participated in a day-long dialogue with ten leaders of local consumer groups on issues ranging from conservation and load management to forecasting and supply and demand planning. Such dialogue is important in developing respect for various points of view. We like many utilities have also established a consumer advisory panel which has provided valuable input over the last two years and we are now embarked on another round of community meetings that will take us over the next ten months into every one of our 40 cities and towns.

These are a few examples of our efforts to reach out to consumers and to all of our stakeholders. In reaching out, we have found that the range of opportunities available to our customers and to us can be expanded greatly. There's no monopoly on new ideas. At the same time, we have found that differences can be addressed, and usually resolved, in a more constructive atmosphere. It is in fact the relationship that exists between a utility and its customers, regulators and elected and appointed officials that allows for innovative, problem-solving actions. I believe we have seen that in Massachusetts and we expect to see more in the future.

Thank you for the opportunity to be here today.

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Mr. MARKEY. Thank you very much.

Our next witness is Mr. Sam Huntington, the president of the New England Electric System.

STATEMENT OF SAMUEL HUNTINGTON

Mr. HUNTINGTON. Thank you, Mr. Chairman, Congressman Sikorski.

The New England Electric companies provide electric service to approximately 1.2 million customers in Massachusetts, Rhode Island, and New Hampshire.

I would like to talk about the planning process and in the next few moments I want to make three points. First, it is extremely difficult in today's world to forecast tomorrow's energy needs. Second, in the face of this uncertainty, we need flexibility, we need flexible plans drawing on a variety of resources to minimize the cost of serving our customers in the future. Our 15-year corporate plan, NEESPLAN II, stresses balanced planning to provide the necessary diversity and flexibility. The plan places strong emphasis on conservation, load management, alternate energy, and renewable resources to assure that these options receive the same scrutinity as traditional utility options.

Finally, my third point is that Government can best serve consumers' interests by encouraging balanced planning and adopting policies which maximize the number of options which can be considered in the planning process.

First, uncertainty. The chart on my right shows the projections of our capacity needs for the next 15 years. If we are successful in encouraging our customers to use our product efficiently, we believe load will grow on our system at an average annual rate of 1.2 percent. If this projection turns out to be correct, we will not need new capacity beyond those projects already underway until the turn of this century. If our conservation programs don't achieve the penetration we hope they will, we could well see load growth at the 2-percent annual rate. Then we would need new capacity in the mid-1990's. Of course, there are numerous other factors that could affect load growth, most notably the price of electricity and the strength of the New England economy.

The implications for planning are clear. We need diverse, flexible plans. Both diversity and flexibility are central to our balanced planning approach. Under balanced planning, the aim is not to achieve the lowest possible cost assuming that all of our planning assumptions are correct. Rather, the goal is to achieve the lowest possible cost in the face of uncertainty.

Let me define just very briefly what I mean by balanced planning. By that we mean that we will use consistent economic criteria in evaluating a broad array of demand and supply options. We start with no preconceived notions that one program is superior to another. Because of the uncertainty we face, we deliberately build diversity and flexibility into our plans. But diversity and flexibility have costs. Let me give a simple example.

Suppose a utility's load forecast shows the need for 1,000 megawatts of new capacity in 1995. If the forecast is correct, a large baseload plant might result in the lowest cost to the utility's

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customers. But if the forecast is wrong, the commitment to a large baseload plant could be a costly mistake. Committing to smaller plants, buying limited ownership shares in several plants, diversifying fuel sources, or investing in other resources such as conservation and alternate energy, may minimize the consequences of forecasting errors.

NEESPLAN II is our response to planning uncertainty. It recognizes there is no single best solution. We will identify and evaluate as many options as possible and come up with a menu of demand control programs and supply projects. The mixture of options will allow us to choose and adjust our choices as circumstances change, always with the central aim of minimizing the cost of our product.

Some of the current NEESPLAN II activities include a pilot conservation program for some 35,000 customers in selected communities in Massachusetts—and, by the way, this program employs the shared savings concept—a photovoltaic project in Gardner, which is the largest of its type in the world and was mentioned by the Governor in his remarks, an array of alternate energy projects, and also the evaluation of various supply alternatives.

Now, briefly, the role of government. In order to allow balanced planning to work, the range of options available to utilities should not be artificially narrow. Adoption of legislative or regulatory policies which discourage capital-intensive projects, for example, would simply bias the planning process away from commitments to new generating units, even though such units might have a place in a particular plan.

One of the best examples of a policy that has outlived its usefulness is the prohibition in the Fuels Use Act against construction of new plants using natural gas as a fuel. A strong case can be made in many areas that gas-fired plants are economic. Yet the legislation now on the books prevents that option from being evaluated and compared to other options.

In conclusion, I believe that the balanced planning process can form the basis for a new consensus between utilities and government. We can work together to assure that all options are considered and evaluated using consistent economic criteria. We can build diversity and flexibility into our plans to minimize the impact of forecasting error. We can then proceed to implement the rich mixture of options that is necessary to maintain a reliable, least-cost supply of electricity for our customers, both in the near term and over the long term.

Thank you.

[Testimony resumes on p. 56.]

[The prepared statement and attachment of Mr. Huntington follows:]

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UNITED STATES HOUSE OF REPRESENTATIVES
COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

STATEMENT OF SAMUEL HUNTINGTON
OCTOBER 21, 1985

My name is Samuel Huntington. I am President and Chief Executive Officer of New England Electric System (NEES). The NEES companies provide electric service to over 1.2 million customers in Massachusetts, Rhode Island, and New Hampshire.

It is a pleasure to appear before the Committee. Today's topic--Massachusetts Energy: Innovative Models for the Nation--reaffirms the importance of energy policy to the nation and our own state. Energy is a critical component of our economic well being. Events ranging from OPEC oil embargoes to Hurricane Gloria demonstrate that its cost and supply are subject to uncertainty. These uncertainties are compounded in our future planning. Today, I will focus first on the sources of planning uncertainty. I will then discuss our response to this uncertainty through the Balanced Planning process, which is the cornerstone of NEESPLAN II, our 15-year corporate plan. Finally, I will address the role of regulators and legislators in the process. We should work together to:

- Maintain as many options as possible for consideration in the Balanced Planning approach;
- Create a level playing field upon which all options can be evaluated consistently and implemented economically; and
- Review proposals during the implementation phase in a way that minimizes disruption to the project under review and deals realistically with prior decisions and commitments.

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I. SOURCES OF PLANNING UNCERTAINTY

Utility planning, like all planning, depends on forecasts. Utility forecasts, like all forecasts, can be wrong. No one can predict with certainty the problems that we may encounter over the next fifteen years.

Yet, we must try. During recent years, we have significantly improved forecasting methods. For example, today's long-term load forecasts are based on a detailed end use analysis of our customers and their appliance choices. We survey our customers to determine the number of refrigerators, freezers, air conditioners, and other appliances on the system, and aggregate the usage from the bottom up to arrive at projections of kilowatthour use in the residential class. Our forecasts are also based on region specific projections of economic activity in the commercial and industrial sectors. The result is a detailed, sophisticated, and theoretically sound projection of future sales growth.

However, the projection is subject to numerous uncertainties. The first uncertainty is price. The dramatic price increases in the 1970's, driven primarily by OPEC price increases, caused significant conservation by our customers. The impact of this particular uncertainty should be lessened in the future as the result of our coal conversion at Brayton Point and Salem Harbor. Nevertheless, the experience demonstrates that the price of our product affects customer usage directly through conservation, and indirectly by changing

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the relative prices of electricity and alternative energy sources.

Electrical usage is also affected by uncertainty associated with the other variables in the model. Specifically, the accuracy of the forecast depends upon the projections of economic activity, population growth, appliance efficiencies, penetration of conservation programs, the potential for new uses for electricity, weather, and numerous other imponderables. Finally, the forecast is premised upon a degree of continuity. Major societal changes, such as wars, major technological breakthroughs, or deep-rooted shifts in social values, are not reflected in the analysis. Nor are major changes in social policy that are directed at energy usage or underlying economic development in our service territory.

Similar uncertainty exists on the supply side of the planning analysis. The continued operation of existing facilities can be affected by equipment failures, changes in social or regulatory policy, or the price of fuel. The availability of new generation from alternate energy sources depends not only on the price of electricity and the operation of the generator, but also on the success of the owner's related business activity. For example, electricity from cogenerators is usually a byproduct of a firm's basic industrial or heating process. The success of a trash burner depends on tipping fees as well as revenues from electric sales. Finally, the uncertainties associated with new utility

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generation are all too familiar and will not be recapitulated here.

II. THE RESPONSE TO UNCERTAINTY--BALANCED PLANNING

How then do we plan in an uncertain energy world? We must deal directly with uncertainty in the planning process. We can no longer accept our best forecast as a given and develop the single, most economic solution under the forecast conditions. We must assume change and develop solutions that minimize cost when change occurs. Two primary strategies are available to minimize the impact of uncertainty in planning decisions--diversity and flexibility. Diversity is premised upon the use of different resource options to achieve the ultimate objective. Flexibility focuses on each option and our ability to adjust its course as change occurs.

Both diversity and flexibility are central to our Balanced Planning approach. Under Balanced Planning, the aim is not to achieve the lowest possible cost assuming that all planning assumptions turn out to be correct. The goal of Balanced Planning is to achieve the lowest possible cost in the face of uncertainty and on the understanding that reality may not match our forecast.

Both diversity and flexibility have costs. A simple example illustrates the concept. Suppose a utility projects that it will be 1000 megawatts short of capacity by 1995 and that the lowest cost option for meeting this need is the construction of a large, baseload coal unit. If both forecasts of need and cost turn out to be correct, the utility that

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builds the baseload coal plant will have achieved the lowest cost supply program.

But, what if the forecasts are wrong? If load growth is less than forecast, the utility would find itself locked into a major construction program in advance of need. Recognizing this uncertainty, the utility may choose to add capacity in smaller increments, either by building smaller, less efficient plants or by purchasing small ownership shares of several projects, recognizing that it will have limited control over each. Both of these options add flexibility, but each has a cost. In the first, the price is the lower efficiency of the unit. In the second, the loss of efficiency is avoided, but the price is the loss of control over the construction and operation of the projects.

Similarly, the cost projections for the coal unit or coal prices may turn out to be incorrect. In that event, the utility may find itself with a major capital investment in an uneconomic plant. To address this uncertainty, the utility may elect to diversify its resource mix and invest in noncoal-fired generation even though these sources are more expensive than coal under the forecast conditions.

The central point is that building the 1000 megawatt coal plant is the lowest cost option <u>if, but only if</u>, the underlying forecasts are correct. The baseload coal plant can turn out to be very costly if the load does not materialize or if the economics of coal burning change. Committing to smaller

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plants, buying limited ownership shares in several plants, diversifying fuel sources, or investing in other resource options may result in higher costs than the single best solution to the forecast conditions. But these higher costs may be a small price to pay in view of the uncertainty associated with the underlying forecast.

Diversity and flexibility allow us to hedge our bets. Diversity reduces reliance on any single resource option. Flexibility allows a more rapid response to change in underlying conditions. Both counsel against large commitments in the single best solution at any point in time. Both are necessary to achieve and maintain the least cost solution over an extended period under a variety of economic conditions.

III. NEESPLAN II--BALANCED PLANNING IMPLEMENTED

NEESPLAN II represents our response to planning uncertainty.[1/] It is a significant break from traditional utility planning. The traditional planning approach arrives at the best available forecast, assumes it as a given, and then develops and implements the single best solution to the forecast conditions. NEESPLAN II recognizes that there is no single best solution. Rather, there is an array of energy resources available to meet our public service obligations. Under NEESPLAN II, we evaluate this array of resources much as an investor would approach the stock market. We do not invest

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1/ The Executive Summary of NEESPLAN II is attached. The NEESPLAN II discussion of Balanced Planning and Conservation and Load Management were presented to the Committee on September 5, 1985, in the testimony of Gerald R. Browne.

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all of our capital in any one option, just as the investor does not invest all of his money in a single stock. Rather, we review the entire spectrum and structure a portfolio of investments to achieve our public service obligations.

The portfolio approach to utility planning incorporates both the elements of diversity and flexibility into the long-term plan. The diversity stems from the use of all available resources. The NEESPLAN II resource list includes demand-side solutions as well as supply-side programs. Conservation and load management are central to our long-term utility plan. On the supply side, the list of resources includes alternate energy, extending the lives of existing facilities, and new generating sources.

By pursuing all these different options, we go far toward reducing the impact of forecast uncertainty. Like an investor who buys several stocks, we invest in a variety of energy resources. By investing in different programs, we reduce the impact of any single uncertainty on our future planning. The entire plan no longer depends on a major investment in a single solution. To the extent that an uncertainty affecting any specific investment occurs, the diminished benefits from the investment may be balanced by better than expected results from investments in other resource options.

Because of planning diversity, the adverse impact on the utility and its customers of lower than expected load growth is minimized. The reduced reliance on any single resource option improves our flexibility. By spreading our investments among

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many resources, we have the ability to respond effectively to changes in underlying economic conditions. For example, the utility that devotes all of its resources to a single 1000 megawatt plant may be forced to continue even though only 500 megawatts are ultimately needed. The utility that meets the projected 1000 megawatt need with five different projects of 200 megawatts each can respond much more quickly and effectively to the change by adjusting several of the smaller individual projects all of which will be at different stages of planning or implementation.

For these reasons, both diversity and flexibility are central to the Balanced Planning approach. The next step in the process is the selection of specific investment choices. We want diversity and flexibility, but which of these resources do we choose and how much do we invest? To answer this question, we have developed a set of consistent economic criteria drawn from our marginal costs. The marginal cost analysis is not based on our best estimate of 1.2 percent annual load growth and a projected need for new generation in the year 2001. Rather, it is based on the single, largest uncertainty associated with that forecast--the possible need for new capacity in 1995, six years sooner than anticipated based on a higher growth rate of two percent. The different projections are shown on the attached chart. The potential for a capacity deficiency in 1995 is the major uncertainty in the forecast; our planning is geared to avoid that uncertainty. Thus, the economic evaluations for investment decisions are

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based on the potential need to add new generating capacity in 1995.

The economic criteria derived from this analysis are then applied consistently to all resources available to the system. Under our current analysis, our marginal costs of about seven cents per kilowatthour are used to evaluate investments in conservation and load management, alternate energy, life extension programs, or new generating sources. The key point is that the same economic criteria are consistently applied to all resources available to the system, whether demand-side or supply-side and whether new, old, or purchased. We thus establish objective benchmarks to apply to all investment opportunities and to create a framework for investment decisions. This consistent economic evaluation forms the platform for our Balanced Planning initiatives.

The Balanced Planning approach is now being implemented. Early on, we recognized some gaps in the analysis. For example, we were not sure how much conservation we could buy from our customers with incentive programs. Thus, we have embarked on one of the most extensive conservation programs in the country--our Enterprise Plan. Under the Enterprise Plan, we are implementing all kinds of incentive programs--loans, grants, and shared saving plans--for 35,000 residential, commercial, and industrial customers in 20 Massachusetts communities. The results of this program will allow us to evaluate the impact of conservation incentives on customer usage, select the programs which are most effective, and design

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the systems for large-scale conservation programs. We will learn how much conservation the incentive produces, identify problems, and evaluate the fairness to all concerned.

Our pricing policy for payments to developers of alternate energy sources is consistent with our economic criteria under the Balanced Planning approach. We are also using these economic criteria for analyzing investments to extend the lives of our existing facilities. We have continued our evaluations of our current construction program, including Millstone Unit 3, Seabrook Unit 1, and the Hydro-Quebec project, and concluded that completion of these projects is necessary, appropriate, and economically sound under our Balanced Planning approach. Opportunities for new generation are being evaluated using the same economic principles. If they meet the economic criteria, they will be further considered for flexibility, risk, and operational soundness to arrive at a reasoned investment decision.

Finally, we have focused on new technologies. We have commissioned the largest cluster of photovoltaic installations in the world. We are going to install photovoltaic systems on 30 houses in a neighborhood in Gardner, Massachusetts, as well as the library, city hall, a local restaurant, store, and community college. This very exciting project will allow us to evaluate the customer acceptability of these systems and to test their operating performance under a wide range of conditions. It will also allow us to determine the impact of these systems on the local distribution system and our

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electrical facilities. Construction has begun. The first installation at the city hall is now complete. The dedication ceremonies for the project will occur in Gardner next week on October 24th.

The end result of the NEESPLAN II planning process will be a menu of demand control programs and supply options. Some programs will have short lead times, others long lead times. Some will be relatively easy to implement, others will not. Some will involve relatively high risks in return for strong potential benefits, others will involve little risk and promise only modest benefits. The rich mixture of options will allow us to choose and adjust our choices as circumstances change--always with the central aim of minimizing the cost of our product.

IV. THE ROLE OF GOVERNMENT IN THE PROCESS

Governmental action plays a key role in all utility planning, but particularly in the Balanced Planning process. Governmental action affects the planning process directly by controlling the options available and by determining their relative economics. It also affects implementation through siting, environmental, and construction permits. Finally, government plays a critical review and oversight role for the continuing economics of a utility's ongoing construction program and the costs of a completed plant. All of these processes need to work more efficiently in the future.

A new consensus needs to be developed on the rights and responsibilities of utilities and the proper approach to their

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public service obligations. We believe that the Balanced Planning approach can form the basis for that consensus. But the implementation of the Balanced Planning concept will not be easy. Smaller commitments to a wide array of diverse options means that more projects, more activities, and more approvals will be required to meet the ultimate objectives of a least cost, reliable supply of electricity. The utility that invests in five supply and demand-side projects needs more approvals than the utility that builds the single large coal unit. If the process is to work, and if the benefits of diverse, flexible planning are to be realized, we must restore a rational and efficient system of utility and government relationships.

Three elements are central to the Balanced Planning process. First, we must maintain as many options as possible for use in the planning process. Second, the permitting process for each option selected must proceed efficiently and fairly. Third, we must create a system of reasoned review for ongoing implementation programs that does not undermine the project being reviewed and deals realistically with prior approvals and commitments. Each of these elements will be addressed in turn.

A. Maintaining Planning Options

The success of Balanced Planning depends on the availability of a wide range of options for evaluation. If an option exists, it can be tested against the economic criteria and implemented to the extent economically justified. If it is

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ruled unlawful, the option may not even be included in the threshhold analysis. In the past, we have tended to overreact to energy problems by, for example, flatly prohibiting the construction of gas burning facilities after natural gas shortages. This fuel source has now become much more economical under today's conditions. The lower fuel price of gas together with the relatively low capital cost of gas-fired generation provides potential benefits that should be considered in any long-term plan.

The point here is not that we should build any particular generating station or use any particular fuel source, but that we should maintain as many different sources as possible for consideration in the planning process. The options for planning purposes should be as broad as possible.

Moreover, all the options should be evaluated consistently on a level economic and regulatory playing field. We should recognize conservation, load management, alternate energy, and conventional generation all as valid options to meet our electrical needs. The first question is which mix of these options produces the least cost plan for a reliable electricity supply. Ideally, the choices for that mix should be based on the total economic benefits produced by each option. These choices should not be artificially biased by discriminatory tax provisions or uneven regulatory policies. All options meet the same objectives. All should be treated similarly as a matter of government policy. The key benefits of Balanced Planning--diversity and flexibility--depend on having options

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available to evaluate and implement, and on having the ability to adjust to changes as uncertainty is experienced. For the process to work, we must maintain options and the level playing field on which to evaluate them.

B. More Efficient Approval Process

After the options are evaluated and the plan developed, the permitting process begins. Once begun, it continues for an extended period as reports are written, cases are litigated, decisions are written, appealed, remanded, modified, or affirmed. The approval process is complex, confusing, inconsistent, and just plain inefficient.

Nevertheless, the basic approach is sound. Utilities should have the responsibility to build consensus and convince regulatory agencies of the merits of their proposals. We should continue that approach within the existing system and avoid new layers of complexity. We should also try to simplify the procedures for approving a project at the agency level, shorten permitting lead times, and focus the cases on the merits of the proposal. Finally, once a project is approved, we should take the necessary steps to implement it as efficiently as possible and at the lowest possible cost to customers. Licensing uncertainty and delay have real costs and significantly limit planning flexibility. We should recognize these costs and this loss of flexibility, and remedy it within the context of the present regulatory framework.

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C. Reasoned Review of Ongoing Programs

The final step of the Balanced Planning process focuses on implementing the approved program. Both utilities and regulators have an important role in this process as well.

Balanced Planning is developed as a response to uncertainty in forecast conditions. We know that underyling conditions will change, and that the change will adversely affect some of the many, diverse programs that we have undertaken to meet our public service obligations and our NEESPLAN II objectives. Like the investor in the stock market, some choices may not pan out. Hopefully, others in the portfolio will make up for the shortfall and limit the risk associated with any single uncertainty. But in any event, we must be prepared to monitor our progress and cut our losses if necessary.

Thus, both utilities and regulators must maintain the flexibility to review prior decisions in the light of new facts. But both must be prepared to deal realistically with prior decisions and actions. Moreover, the reviews of ongoing programs should be completed in proceedings that are conducted in a way that has minimum impact on the progress of the underlying project. The analysis should focus on the performance of the entire portfolio and the project's role within the long-term plan. Finally, the resulting decisions must be consistent with our commitments and obligations to others including our customers, investors, and contractors.

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CONCLUSION

Utilities and government must directly address uncertainty in the planning process. Our solution is the Balanced Planning approach. Balanced Planning is premised on diversity and flexibility. It is implemented through the consistent economic evaluation of all resource options on both the demand side and supply side. Its goal is to achieve the lowest possible cost in the face of uncertainty and under a wide range of economic conditions.

We believe that the Balanced Planning process can form the basis for a new consensus between utilities and government. Central to its success is maintaining as many options as possible and a level playing field upon which they can be evaluated, assuring a fair and efficient approval process for the many demand and supply-side programs that we will be proposing, and developing a rational and realistic system for continuing review of ongoing programs in light of current facts. With these elements in place, we can proceed to implement the rich mixture of options that is necessary to maintain a reliable, least cost supply of electricity for our customers over the long-term future.

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NEES Capability Position

Based on 20% Reserve After 1991

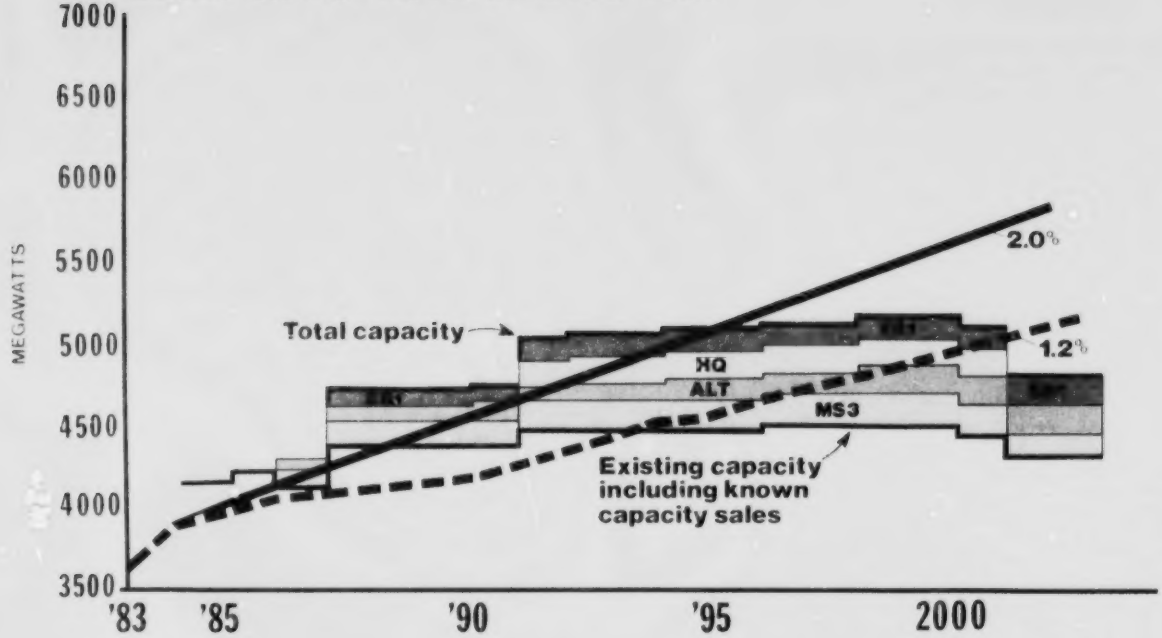

FIGURE 1

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New England Electric

NEESPLAN II

BALANCED PLANNING FOR THE FUTURE

The goal of NEESPLAN II is to structure the least-cost strategy to serve our customers for the long-term future. The significance of NEESPLAN II is that the goal is achieved with the use of all of the options available to the System. The original NEESPLAN started the process by incorporating conservation and load management in our long-term supply planning. In NEESPLAN II, these elements are fully integrated into the portfolio of resources available to assure a reliable, least-cost strategy for meeting our service obligations to customers during the next 15 years.

As in a portfolio, all options are evaluated on a consistent economic basis. Each economic option is maintained, but reliance on any single solution is avoided. The goal is to minimize cost and maximize flexibility. The result is a diverse, reliable, and low-cost energy supply. In NEESPLAN II, the portfolio of resources contains conservation, load management, small power producers, our existing generating facilities and entitlements, and new generating sources.

Each of these resources plays a different but complementary role in our long-term planning. All are used to achieve the ultimate objectives:

A. Provide an adequate supply of electricity to our customers at the lowest possible cost, and

B. Encourage customers to use electricity efficiently.

These two objectives establish the economic principles underlying NEESPLAN II. They lead to balanced planning using consistent economic criteria.

The fundamental lesson of the past 15 years is that no single best option exists for our energy future. The major problems faced by the utility industry have stemmed from a large commitment to the single best available solution at the time. Our System has avoided those large commitments in the past. We will continue to avoid them in the future. Conservation, load management, alternate energy, interregional energy purchases, existing facilities, and new generation are all valuable tools in our efforts to provide customers with a reliable and diverse supply of energy at the lowest possible cost. No single alternative should be selected to the exclusion of others. The challenges are too great; conditions change too fast. The best option today may become uneconomical tomorrow.

NEESPLAN II places all the available resources on a consistent economic basis and pursues each option to the extent it is economical. It initiates and continues investments in a diversified portfolio of resource options. Like a well-managed investment program, it should lead to a consistent return of savings for our customers with sufficient diversity to limit the risk of disruption or price shocks that have threatened the industry during the last decade.

NEESPLAN II's objectives, and the economic bench marks they produce, will be used consistently in our long-term planning. The results of our initial efforts are set forth in this document. But NEESPLAN II, like the original NEESPLAN, is only a start. It will continue to be modified as we develop new ideas and face new challenges.

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THE ELEMENTS OF NEESPLAN II

The application of balanced planning affects every aspect of the System's business. NEESPLAN's twin objectives of providing an adequate supply of electricity to our customers at the lowest possible cost and encouraging customers to use electricity efficiently are achieved with an array of resources and programs. Under NEESPLAN II, these resources are evaluated consistently to create a least-cost, low-risk strategy for our customers over the next 15 years.

Conservation and Load Management

One of the primary goals of NEESPLAN II is to encourage our customers to use energy efficiently. This goal is accomplished through conservation and load management. It recognizes that our customers are our most valuable resource. Their usage patterns directly affect our costs. The date when new capacity is needed for reliability purposes depends not only on the resources available to supply electricity, but also on the amount of electricity demanded by our customers. The usage patterns of our customers also contribute to the efficient use of our generation, transmission, and distribution facilities, and reduce energy costs on the system. Our goal is to deploy those conservation and load management programs that are economical under our balanced planning approach. Thus, efficient electricity usage by our customers plays a vital role in meeting our first objective—to provide an adequate supply of electricity at the lowest possible cost.

We expect that conservation and load management programs will enable us to hold load growth to 1.2 percent per year. The forecast is our best estimate of load growth. Meeting the forecast will be a challenge. Electricity usage by our customers is sensitive to its price. During the past decade, the dramatic increases in electric rates caused by oil increases spurred intensive conservation by our customers. The movement to conservation was immediate and pronounced.

However, conditions have changed. During the last four years, the real price of our electricity has dropped by approximately 12 percent as the result of coal conversion, lower oil prices, and other NEESPLAN programs. In the past two years, load growth has increased by more than five percent per year. Though we attribute much of this growth to improved economic conditions in our service territory, it signals a need for an increased focus on conservation programs. The savings and price stability from coal conversion and other NEESPLAN programs have affected our customers' incentive to conserve. It is much easier to justify conservation measures when electric rates are high than when they are low. A higher rate of two percent in annual load growth, rather than the 1.2 percent estimate, advances the date when new generation is needed for reliability purposes from 2001 to 1995. The economics of our conservation and load management programs are judged against the costs of that possibility.

NEESPLAN II is designed to maintain our customers' commitment to conservation and the efficient use of energy through the next 15 years. Efficient use of electricity begins with the proper pricing of our product. Under earlier NEESPLAN programs, we instituted a number of marginal cost rates. These rates send our customers the proper price signal by reflecting the full costs of consumption during peak periods when costs are highest and the full benefits

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of consumption during off-peak periods when our costs are lower. Time of use pricing for our largest customers has been implemented in Rhode Island and is now proposed in Massachusetts. We have also modified all our rate designs to assure that tail blocks fully reflect our marginal costs. In this way, our customers will realize the full benefits of saving electricity. The savings from the kilowatthour that they conserve will reflect the oil that we do not have to burn.

Under traditional economic theory, a proper price signal should spur the proper conservation. But traditional economics may not achieve our goal. We recognize that additional incentives may be necessary. Thus, we are undertaking several pilot programs to test the impact of conservation payments or incentives on the electricity usage by our customers. The programs have been designed for each customer class—residential, commercial, and industrial. Several approaches are being tested, from low-cost financing to shared savings to outright grants. The amount of the payments and incentives is determined by the same economic principles that are applied to our other programs.

These programs are designed to test the responsiveness of our customers to conservation incentives. The major projects are targeted to "Enterprise Zones" located in portions of our service territory that have not fully participated in New England's recent economic growth. The programs are designed to stimulate the local economy, as well as to provide invaluable practical experience and hard data on the impact of different conservation approaches and incentives. The programs that we are undertaking will allow us to gain the practical experience necessary to maintain load growth on its most efficient path. Through these programs, we will identify the incentives that work best for our customers. We will create and refine the systems that are necessary for System-wide implementation. We will also address directly the allocation problems that conservation programs present. Conservation payments to one customer group can increase costs to other nonparticipating groups. Any System-wide incentive program must be fair to all groups and lead to the efficient use of electricity. The pilot programs called for in NEESPLAN II will allow us to design that program fairly and efficiently.

Alternate Energy

Alternate energy was another of the programs first set forth in the original NEESPLAN. It has been a success. As the result of our early initiatives, we were first in line with small power producers and cogenerators. In 1979, the goal was 100 megawatts of additional alternate energy over the 100 megawatts then on the System. We have 165 megawatts now operating on the System. An additional 60 megawatts are expected to begin operating this summer, and serious negotiations are under way for about 100 megawatts. The electricity we deliver to customers is now generated with wind, water, wood, and trash, as well as with oil, coal, and nuclear power.

As the result of these successes, we have twice increased our alternate energy goals. NEESPLAN II continues that trend. We now expect 500 megawatts of alternate energy from small power producers and cogenerators by the end of the planning period. We expect that these sources will supply 2.5 million megawatthours of energy in the year 2000.

To encourage alternate energy on our System, we are revising our pricing policy based on the same economic principles used for other resource options.

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We will pay alternate energy sources competitive prices consistent with our least cost analysis. Our contracting policies will be designed to attract more small power producers to our System while providing concrete savings for our customers. The new pricing policy will give us additional flexibility to meet these ends, to capitalize on alternate energy resources, and to assure that our primary goal—an adequate supply of electricity at the lowest possible cost—is achieved. In addition, we are exploring other financing options, other technologies, and other resources in our service area for the potential for future development of alternate energy. We are evaluating the potential for System financing of alternate energy facilities. We will be installing a large-scale, multi-site photovoltaic project as part of our "Enterprise Plan" programs. And we are continually assessing the technology available for applications in the areas that we serve.

Under NEESPLAN II, alternate energy will be a primary source of generation to serve the increased loads and energy requirements of our customers. It makes good sense economically and for New England. We can avoid burning foreign oil by burning New England's trash. We can meet our demands and provide savings to our customers at the same time. Under our new pricing policy, we anticipate that our prior successes at contracting with small power producers will continue and that our 500 megawatt alternate energy goal will be achieved.

Existing Facilities and Entitlements

The existing system is a critical element of any resource plan. The facilities on the present system are our most valuable resource for the future. They will supply the bulk of the future load. They were constructed with low capital costs before the recent period of high inflation. Thanks largely to the coal conversion programs initiated under the first NEESPLAN, they are fueled with a diverse, low-cost mixture of fuels.

Maintaining the savings produced by our existing plants is a primary challenge that we face over the next 15 years. For example, Brayton Unit 3, our largest baseload coal unit, was built in 1969 at a cost of $81.8 million or $129 per kilowatt installed. In 1981, it cost $135.6 million, or $214 per kilowatt, just to convert the unit to coal. The advantage of maintaining Brayton Unit 3 is obvious. It has provided, and will continue to provide, major savings to our customers.

However, Brayton Unit 3 will be 30 years old in 1999. It is one of the newer thermal units in our System. By the year 2000, 1,707 megawatts of the installed fossil-fired capacity in the System will be more than 30 years old, and 569 megawatts will be more than 40.

The age of these units, together with the expiration of more than 350 megawatts of contractual entitlements in the years 2000 and 2001, forms the rationale for a major life extension program under NEESPLAN II. Under the first element of the life extension program, each generating unit will be evaluated for capital improvements and replacements required to extend its service beyond the original expected life. The economic evaluation of the improvements will be judged according to the primary economic principles applied to other NEESPLAN II programs. The benefits of the life extension program over the life of NEESPLAN II will be compared against the avoided capacity costs and the marginal fuel savings that will be produced by the life extension.

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We are also taking steps to assure that the units run well through their extended lives. This is a second element of the life extension program under NEESPLAN II. NEESPLAN II sets an availability target for thermal units of two to four percent above the national average for similar units. For hydro units, the target is to maintain their current high levels of availability. It will be a significant technical and operating challenge to maintain unit availabilities as these units approach the end of their design lives. Our goal is to maintain a high level of performance within the economic constraints of NEESPLAN II. We will develop solutions, operating practices, and maintenance techniques that are justified by the energy savings and reduced reserve requirements that they produce.

The third element of NEESPLAN II that affects existing facilities focuses on fuel. Earlier NEESPLAN programs have centered on coal conversion. We are now turning our attention to natural gas. Changes within the natural gas industry, together with reduced gas demand, have significantly increased the potential for burning more natural gas in our remaining oil-fired power plants. Gas burning can provide both economic and environmental benefits. During the past several years, we have used natural gas at one of our generating stations in Providence during summer months. Preliminary engineering work is under way to determine the potential for adding the capability to burn natural gas at our South Street station in Providence. An evaluation of the potential for converting Salem Unit 4 and Brayton Unit 4 to natural gas is continuing. We are also working to bring gas from our reserves in the Southwest and Gulf Coast to New England for use in our generating stations. Because of the changes in the industry, pipelines are now much more willing to transport this gas for the System. Under NEESPLAN II, natural gas is a part of our diversified, flexible fuel purchasing strategy that has already sharply reduced all of our fossil fuel costs over the last several years.

In short, NEESPLAN II recognizes that realization of our goal to provide an adequate supply of electricity at the lowest possible cost depends to a large extent on our existing plant. The existing generating sources are a valuable, low-cost resource. Our objectives are to extend their lives, increase their availabilities, diversify their fuel sources, and purchase their fuel supplies at the lowest possible cost to our customers. All of these objectives will be achieved within the consistent economic principles established for all programs under NEESPLAN II.

New Generation

The economics of new generation have undergone a fundamental shift in the last 15 years. Until the early 1970s, the generation of electricity was a declining cost industry. A new plant cost less per KW than an old plant. That situation has now turned around, and turned around sharply. Increased environmental requirements, licensing costs, inflation, financing costs, and construction costs all combined to make the construction of a new baseload generating station much more expensive. Long lead-times associated with building new baseload generation stations also limit their flexibility as a planning option. Major baseload units are the workhorses of the System. They are necessary for a stable, reliable supply of electricity. But they cannot be quickly scheduled, permitted, built, and put into service. For these reasons, the completion of the projects now under construction in New England is essential. Millstone Unit 3 is scheduled for commercial operation next year. It will provide the System with 140

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megawatts of baseload capacity. Seabrook Unit 1 is expected to begin commercial operation late in 1986 or in 1987. It is the last major generating unit under construction in New England. It will provide us with an additional 115 megawatts.

The remaining expenditures to complete these units are economically justified. The new baseload capacity will provide valuable long-term additions to the System, diversify our generating mix, and provide insurance against rapid load growth. With Seabrook Unit 1 and Millstone Unit 3, the System will serve its customers with a balanced mix of nuclear, coal, oil, hydro, and alternate energy. The units will introduce new generation into an otherwise aging capacity mix. They will give us the flexibility that is necessary to develop the other resources that we will implement under NEESPLAN II. The units are important elements in our power supply plans.

Our power supply plans also contemplate successful completion of the Hydro-Quebec transmission projects. Together with other New England utilities, the System is building a direct current transmission tie between New England and Quebec. This interconnection will bring power from Quebec's huge hydro developments along James Bay to customers in New England. It is being built in two phases. In Phase I of the project, the System is building the New Hampshire portion of a 450 KV DC transmission line with an AC/DC converter terminal in New Hampshire. Phase I will be completed in 1986.

Phase II of the project is well under way. It is an extension of the DC line to serve a terminal in Massachusetts. The project will allow New England access to Hydro-Quebec's major energy developments at a price significantly below the cost of oil. The interconnection will also improve the reliability of the New England transmission network. The contract for Phase II will provide 160 megawatts of capacity value for the System between 1990 and 2000.

The Hydro-Quebec project emphasizes the importance of interregional electricity purchases as a source of energy and capacity for New England. We will continue to explore this resource and to expand the transmission network if it is economical to exploit it. The possibilities include additional purchases from Canada or from utilities in the Midwest. By strengthening our transmission network, we improve our reliability and allow access to additional electricity sources. The potential for purchases outside the New England region provides a source for both capacity and energy savings for our customers. This potential will be evaluated consistently with all the other options available to the System. It will be pursued to the extent that it is economical for our customers. We will also continue to evaluate the economics of new generating units on our own system. New generation will be added when it is the economical choice to provide an adequate supply of electricity to our customers at the lowest possible cost—our primary objective under NEESPLAN II. The economic principles applied to new generation are the same as those applied to other NEESPLAN II programs. Unlike traditional utility planning, new generation is not our sole solution to supply planning. Nor is it ruled out as an option. Our task under NEESPLAN II is to meet our customers' electricity needs with a diverse, reliable, and low-cost energy supply. We will use all available resources to accomplish this task. The key to NEESPLAN II is the use of consistent economic principles with the flexibility to respond when the underlying economics change. The result is balanced planning.

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Mr. MARKEY. Thank you very, very much.

Let me begin the questioning by asking Mr. Huntington, to what extent would the construction of a national electricity transmission system and the availability of unregulated transmission affect the balanced planning process that you describe in your testimony?

Mr. HUNTINGTON. To what extent would the construction of a national grid——

Mr. MARKEY. Right.

Mr. HUNTINGTON. Of course, we have a very extensive national grid right now of transmission services. Reference was made I think earlier by Joe Kennedy to the difficulty in wheeling power or transmitting power from the Midwest to New England. This is a serious issue. Clearly, if there were additional capability to transfer power from the Midwest to New England, then we could consider purchases from Midwest utilities on the same basis that, for example, we just signed up to buy power from Hydro-Quebec. So that would expand the number of options that we could consider.

The difficulty I see in building an East-West transmission line is primarily a siting one, that you would be attempting to transfer benefits by being able to generate power in the Midwest to New England across Pennsylvania and New York, and the benefits for Pennsylvania and New York would be quite limited. I think you would have a tough time siting the transmission facilities. But, clearly, if it can be done, we're in favor of it and would certainly investigate it.

Mr. MARKEY. To what extent would New England Electric's balanced planning approach be helped or hindered by a national balanced planning process?

Mr. HUNTINGTON. I think nationally the industry, and certainly regulators, are moving in this direction, that we no longer should look just at one set of options but should consider a broad array of options. I heard Steve Sweeney mention in his remarks the approach they are taking, which is very similar to ours.

Mr. MARKEY. What suggestions would you have for Federal legislation that might help you in constructing for New England Electric a balanced planning process?

Mr. HUNTINGTON. I don't see the need for broad Federal legislation to allow the balanced planning process to go forward. I think it can go forward, given the current regulatory situation.

The one example, of course, I gave in my testimony was you can remove barriers to considerations of some options. The Fuel Use Act I think is a very good example of a policy that has outlived its usefulness.

Mr. MARKEY. That has outlived its usefulness?

Mr. HUNTINGTON. Yes.

Mr. MARKEY. You're in favor of repeal?

Mr. HUNTINGTON. Yes.

Mr. MARKEY. You are as well, Mr. Sweeney?

Mr. SWEENEY. Yes, sir.

Mr. MARKEY. Let me ask Mr. Sweeney, in your opinion what would be the proper role of the Federal Government in assisting Boston Edison and other utilities to fulfill their functions?

Mr. SWEENEY. Basically I guess I think we're all looking to do the same thing. In the Federal Government you're looking for a

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balanced energy program and I think we're doing the same thing in our business.

What I would like to see—and you mentioned it in your opening remarks—I would like to see something where we have a levelized playing field. If we're going to have a process out there that is going to be a balanced system, where there are no subsidies or there are subsidies, then all should have it or none should have it. We should all be playing on the same level playing field by the same rules. If that happens, then the free market system ought to, under those conditions, produce the kind of power system we're all looking for.

But when the rules are different and the playing field is a little bit uneven, then that's where you're going to make mistakes in the future.

Mr. MARKEY. Earlier panels this morning alluded to PURPA in developing alternative energy resources. How has that legislation helped or hindered Boston Edison in your resource development over the past 5 years or so?

Mr. SWEENEY. It hasn't done much either way for us. We have had a number of people come to us with some cogeneration projects. Everyone that came to us, we expressed interest, we negotiated with. Some fell out and some stayed in. We have signed four contracts with small power producers and cogenerators out there. We're looking at upwards of 10 to 12 more. We'll sign any contract, go any place in New England, or any place we have to go, to sign a reasonable contract for a reliable source of supply that can help meet our customers' needs. So if you come to us with a legitimate plan and a reliable power source, we're interested and we'll buy.

Mr. MARKEY. My time has expired.

The Chair recognizes the gentleman from Minnesota.

Mr. SIKORSKI. I thank the chairman and want to commend you for what I think is a progressive approach to the problems in receptivity to changes that need to be made in both the regulatory and statutory structure as well as the marketplace, especially Mr. Sweeney, with regards to the level playing field.

How does the Edison Electric Institute get so crazy on issues like acid rain when it has good people like you as members?

Mr. SWEENEY. It's almost a parallel with EEI and Congress. We have people from all over the country in EEI. A midwestern utility has different problems with that than we have here. Getting a consensus on that kind of an issue across the Nation, where the cost to a midwest or western utility could be astronomical as opposed to other parts of the country, it is very difficult to get a consensus on that type of thing, as it is for you in trying to get something through Congress.

Mr. SIKORSKI. Maybe what we need to do then is to form a group of utilities that publicly recognize the problems in their regions. I mean, we can talk about the environment, but the economy is threatened and is damaged tremendously by acid rain. With that recognition, you could form a group of people that can speak out from that perspective. My major utility, Northern States Power in Minnesota, was one of the first that said: "Wait a minute, there is a problem and we're part of it in a sense and we should be doing something about it." They don't embrace what I have proposed be-

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cause they think other utilities should pay the freight of their costs and they pay their own freight.

I'm amazed when I go around the country at the reasoned outlook with which utilities take individually toward problems affecting their consumers. They're in a people business. If you don't have the support of your ratepayers, you're not going to stay in business very long, at least in a respectable fashion. Yet when you get together, your ratepayers eventually help you become a member of the Edison Electric Institute and may come out with stuff that is the equivalent of denying that smoking has anything to do with lung cancer.

Mr. SWEENEY. There are a couple of things I would like to add to that. We feel very strongly here in New England, I think, that our customers in this area have already paid substantially on the acid rain issue. We have had sulfur reductions on the oil. We paid that price. Our customers have paid that price. We are the recipients of acid rain generated elsewhere. Our customers have already paid their dues on this issue. So we would jealously guard something unequal for our customers here in New England as opposed to someplace else. We keep stressing that point.

Mr. SIKORSKI. We do, too, in Minnesota. We have scrubbers and everything. Wisconsin, for example, our neighbor to the east, doesn't have a single scrubber on its total system.

Mr. SWEENEY. Your other point about having the ratepayer or the consumer on your side, forums such as this allow the issues to be aired. One of the concerns, as you go around the country and talk about the marginal costing of all your costing, what Bob Keegan was saying, we believe very strongly that you have got to get out there and talk to the consumers. They must participate. Because if the rules are going to be changed so dramatically that it is going to require people to change how they live or use our product, then they ought to understand that. They ought to know what that means and they ought to agree whether they want to play or not play.

So forums such as this, and in our own community meetings that we're having in our 40 cities and towns, they are designed to do just this. We are not opposing. We're just saying this is what it means, and you want to know that.

Mr. SIKORSKI. Does your PUC require you, as part of the ratemaking process, to go out and have town meetings, citizen forums, and all that, or do you do that as a matter of course?

Mr. SWEENEY. We do that as a matter of course. We started that in 1981, when we recognized that you couldn't go forward any more in this ball game by yourself. We were tired of fighting the legislator; we were tired of fighting the regulator. Quite frankly, we had not done a very good job in communicating with our customers. So it was time to get out there and put the issues on the table, get their input. Because of that, we've got many, many new programs, conservation programs, our IMPACT 2000 house, the Symphony Road project. All of these are a direct result of customer inputs that came out of these meetings. We're going to keep holding them, and holding them, and holding them, because it is awfully important to do that in today's environment.

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Mr. HUNTINGTON. If I could just add, one thing that we discovered in our pilot conservation program is that it is absolutely essential to involve community groups in reaching our customers. We have the community action councils, for example, deeply involved in actually marketing our conservation program to our customers. Based on our experience in these towns where the program is going forward, we will then be able to implement this on a system-wide basis.

Mr. SIKORSKI. Let me ask one last question on the wheeling issue. Do you really need the transmission lines? Aren't there transmission lines in existence as part of the national grid that could be utilized more efficiently but aren't because the ownership aspects don't allow for carriage?

Mr. HUNTINGTON. My response to that, Congressman, is that by and large most energy transfers that improve economic efficiency—in other words, if there is a low-cost source of power in one part of the country and it could displace high-cost power in another part of the country—are taking place to the extent that the transmission system is adequate and to the extent there is transfer capability available.

What we see when we try to buy cheap power from the Midwest is that, in fact, there is not adequate transfer capability. Those lines are loaded to the limit. In other words, you may be able to buy energy for short periods during some times of the day or some times of the year. You cannot get reliable, firm power.

In our contract with Hydro-Quebec we are building a large, 2,000-megawatt, direct current transmission tie which will enable us to import that very economical power. We don't have a similar ability to buy power from the Midwest. We would have to build a new line for that.

Mr. SIKORSKI. Thank you.

Mr. MARKEY. Thank you very much.

Let me just move into one other area, and that is the area of solar energy. What role do you see solar energy playing in our energy mix in New England in the next 20 years or so?

Mr. HUNTINGTON. I see it as playing an important role. I would differentiate between passive solar energy or space heating solar energy. I think that technology is available and is being applied by people building new houses and to some extent retrofitting. It can have and is having a significant impact on the use of all types of energy for space heating.

Photovoltaics, you're going to hear a lot more about that from the next panel. I'm as interested as you are in learning about the potential. We do have this experiment in Gardner where we will attempt to get the necessary data to see how these systems interface with the utility system. It is a very exciting option.

Now, whether there will be significant impact in the next 5 years, or whether it will be more like 10 or 15, I think you probably should ask the next panel.

Mr. MARKEY. Mr. Sweeney, do you have any view of what percentage of the mix these renewable energy resources might be able to contribute to the New England or Massachusetts energy needs over the next decade or so?

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Mr. SWEENEY. I wouldn't say a percentage, per se, Congressman. I think I would agree with Sam. We have done any number of projects, such as a project at Bentley College we put in a number of years ago, our own IMPACT 2000 house. We see these as providing some important contributions in the local areas, in the homes and apartment complexes of the future. But whether it will have a big role, any more than a load management or conservation program, remains to be seen. You have got to see what happens, and what the price is going to be, and can the homeowner afford it, can he put it in.

Mr. MARKEY. Electricity consumption for a while leveled off and even dropped off to some extent back in the late 1970's in response to the energy crisis. What has happened to the demand for electricity in New England since that dramatic moment when people began turning up their thermostats and their lights very early in the evening as we have returned to normalcy in some people's mind? Has the electricity demand increased, has it increased dramatically, and has it increased in a way that is, to your way of thinking, potentially the roots or the seeds for an energy crisis, an electricity crisis, in the near term or the midterm in this country?

Mr. HUNTINGTON. For the last 10 years it has grown about 2.2 percent—that is, from 1974 through 1984. Now, that——

Mr. MARKEY. That's 2.2 percent——

Mr. HUNTINGTON [continuing]. Per year.

Now, that masks quite a bit of volatility. For a number of years, in the mid-to-late seventies, it was essentially flat. Then it picked up quite dramatically—I'm talking about our system. It was 5.5 percent during 1983 and 1984. It has leveled off a bit this year. We are projecting about 2.7 percent in 1985.

Now, in terms of the future, our projections are that it will level off, and if we are successful in our conservation programs, we can keep it down below 2 percent. But there is a great deal of uncertainty there, which is what I referred to in my remarks. Certainly it could be 2 percent or it could be higher, given factors beyond our control.

We are projecting, for example, that the real price of electricity will actually decline. After you factor inflation into the price, the price of electricity will decline over the next 15 years. Now, this runs directly counter to our interest in encouraging our customers to use electricity efficiently. That is one of the big unknowns in trying to forecast growth.

Mr. MARKEY. Mr. Sweeney, do you want to comment on that area?

Mr. SWEENEY. As Sam said, it is a volatile situation. Here in Boston we have seen two 6-percent years. You've got a city here that is still——

Mr. MARKEY. Which means that it increased by 6 percent the last couple of years in a row?

Mr. SWEENEY. The last 2 years. This year, as Sam says, it is a little bit lower than it was, but that is mostly because we have a very, very weather-sensitive system here, especially in the city of Boston. This summer we had basically a cool summer so we didn't get the air-conditioning loads that we normally would get for a long, hot summer like we had in 1984. If we get a very mild winter,

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again you will not see so much load growth. The weather portion of that growth at 6 percent each year is a combination of about 4 percent of the growth that we saw in the city of Boston and about 2 percent came out of the fact that we had hot weather in the summer and a cold winter. In 1985, we have not seen that so far and I think the load is down because of that.

But there is still growth out there. What you're going to find on the basis of all New England, if that forecast is correct, you could probably hang in there with the Hydro-Quebec purchase and a few more things you've got planned and may not have to build anything large in this area or add to this area until the mid-1990's or beyond that. But if that turns around, and if the economy continues to go the way it is in certain parts of this area, then you're going to have to see some capacity provided someplace along the line by some utilities.

Mr. MARKEY. Thank you very much.

Just for your information, when Mr. Sikorski or I begin to espouse our energy philosophies, there are people who gulp who come from other parts of the country. I have to note here publicly that, in fact, when we serve up examples of what you have done in these areas and what other utilities in the country have done—what Southern California, Pacific Gas & Electric, and other more progressive utility executives have been able to do as examples of what is possible—that we elicit gulps from those less progressive utility executives who have a lot of explaining to do as to why they haven't been able to make similar kinds of progress in breaking through some of the old stereotypes.

We hear a lot about central power station units, but we don't hear a lot about the sophisticated, long-term planning that we're hearing here today that is going to be necessary to put together a range of policies and programs to be able to deal with this problem. So we compliment you for the work you have done and we encourage you to continue. We thank you very much for your testimony here today.

Mr. SWEENEY. Thank you, sir.

Mr. HUNTINGTON. Thank you.

Mr. MARKEY. Our final panel consists of those companies here in Massachusetts that are looking at the new ideas, the new concepts that will make a difference. I would ask all of these panelists to come forward. We will take you four at a time at the witness table, and then we will hear from all of you.

The first group we would ask to come forward is Mr. Roger Little, the president of Spire Corp. from Bedford, MA,; Mr. Paul Wormser from Mobil Solar Energy Corp.; Miss Laura Dubester, director for the Center for Ecological Technology; and Dr. George Hatsopoulos, president of Thermo Electron Corp. of Waltham, MA.

Behind them, so we perhaps can move in and out in the course of this testimony, we would ask them to come up now to the witness table. We have four chairs to be put right behind so you can move in and out of the area where the microphones are. Those would be Mr. J.J. Briody, senior vice president, industrial/commercial lighting division, North American Philips Lighting Corp.; Dr. Ronald Goldner, professor of electric engineering, Electro-Optics Technology Center, Tufts University; Mr. Mark Fortin, manager, mechani-

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cal engineering, and Mr. Bill Aikenhead, senior staff scientist, U.S. Windpower Co. of Burlington, MA; and Mr. Steve Miliaras, managing director, ENERGO Technology Corp. of Cambridge, MA. If you could all please come forward.

We will begin this round by asking first the witnesses to present to us, in as concise a form as possible, the ideas that you want us to take from this hearing, the big ideas and concepts that you think are important for citizens of the Commonwealth and the country to understand and to begin to become more strong advocates for. I ask as part of that that you limit your opening statements to 5 minutes, to no longer than 5 minutes, which will allow the subcommittee to get into more detailed questioning on the specific areas of interest that you raise, but also on some of the broader policy questions which we would like you to address and to give some guidance to the Congress on.

So let us begin by again asking that you limit your opening statement to 5 minutes, with the understanding that you will be given opportunities in the questioning to get out some of the other points which you might like to make in more detail. But for the interest of having this panel move on on a fairly expeditious basis, since there are eight of you to testify and we don't want to move on into the afternoon before we reach the further question-and-answer period, we would ask that you do abide by that time limitation.

Let's begin with Mr. Roger Little, who is the president of Spire Corp. He has testified before Congress before. He has a wide audience in Washington and in the State for the issues that he cares about. We welcome you, Mr. Little, and we look forward to your testimony.

STATEMENTS OF ROGER G. LITTLE, PRESIDENT, SPIRE CORP.; GEORGE N. HATSOPOULOS, PRESIDENT, THERMO ELECTRON CORP.; LAURA DUBESTER, EXECUTIVE DIRECTOR, CENTER FOR ECOLOGICAL TECHNOLOGY; AND PAUL WORMSER, REPRESENTING MOBIL SOLAR ENERGY CORP.

Mr. LITTLE. Thank you, Mr. Chairman.

Ladies and gentlemen, Mr. Chairman, photovoltaics is the conversion of sunlight directly to electricity, and we have examples of photovoltaic modules here on display. Photovoltaics is a field in which Spire is a leader. We manufacture equipment and production lines for manufacturing photovoltaic modules. In addition, we do innovative research to forward the technology of photovoltaics to reduce its cost for broad application. This particular module was made using Spire photovoltaic manufacturing equipment.

We sell this equipment to individual manufacturing companies as well as all over the world in turnkey factories. The principal market for photovoltaics is international because of the need for electricity among villages, for village lighting, water pumping and the like.

Massachusetts has historically been the leading supplier of photovoltaic products in the United States. The State has been very innovative in supporting this field through projects such as the Photovoltaic Center of Excellence. This will provide some practical assistance to the Massachusetts industry.

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The State's initiative is important because photovoltaics does have tremendous economic potential for the State as well as national implications for the energy picture. Although there has been a recent decline in oil prices, there still is a concern throughout the world for electricity generation. In addition, it is difficult to predict what the price of oil will be in the future. As the demand for photovoltaic energy grows worldwide, Massachusetts has an opportunity to be a key supplier of products.

However, photovoltaics is still an emerging technology. We must reduce the cost. To do this, we must promote the industry bring it to a state of being healthy so that it can invest and reduce its cost through improved manufacturing techniques and technology.

One of the aims of the Photovoltaic Center of Excellence is to assist Massachusetts companies in reaching international markets. This is extremely valuable since we're currently relying on international dollars in the near term to promote the industry.

The key to significant expansion of domestic photovoltaics is a reduction in cost, to make photovoltaic power more competitive with other means of power generation. Although the price of photovoltaic modules has fallen drastically in the past, we must bring it down some more. This can be done through innovative, creative research, as well as improved manufacturing technology. It is programs such as the State has adopted which will enable companies to stimulate interest among foreign businessmen and encourage technology development. This support is very valuable.

Thank you very much.

[The prepared statement of Mr. Little follows:]

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TESTIMONY
"Massachusetts Energy: Innovative Models
for the Nation"
Roger G. Little, President
Spire Corporation
Bedford, Massachusetts

Photovoltaics, the direct conversion of sunlight into energy is a key renewable energy source. Photovoltaics is a field Spire has become a leader in through the manufacturing of equipment for the production of photovoltaic cells and modules. In addition, we carry on extensive, innovative research aimed at increasing efficiency and lowering the cost of photovoltaic energy.

Spire sells not only individual pieces of equipment, but complete turnkey factory lines for the production of photovoltaic modules. In selling these turnkey production facilities, Spire supplies not only manufacturing equipment but technology and training allowing the implementation of a factory capable of producing 1 Megawatt of solar modules per year.

Photovoltaic modules are used throughout the world for a variety of applications. Photovoltaics is particuarly important to developing nations and in remote areas which have a need for electricity for such uses as village lighting, water pumping and refrigeration.

Massachusetts has historically been a leading supplier of photovoltaic products. The State has certainly been innovative in supporting this field through projects such as the Photovoltaic Center of Excellence which will provide practical assistance to the industry. The State's initiative in supporting photovoltaics is important because photovoltaics has tremendous economic potential for Massachusetts.

Athough there has been a recent decline in domestic oil prices, most of Spire's photovoltaic manufacturing equipment business is in the international market. Internationally, the price of oil has not declined. Worldwide, the most significant applications of solar cells are in areas where electricity is not otherwise available. The main factor in comparing solar-cell electricity to other sources is the cost of bringing in electric power lines or diesel fuel from a distance, not the cost of the fuel consumed.

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As the demand grows worldwide, Massachusetts has the potential to remain a key supplier of photovoltaic products, providing increasing numbers of jobs and revenue for the State. However, photovoltaics is still an emerging technology. Most of the current demand is overseas especially in developing nations which have a need for power in remote locations. In order to continue to expand and support the international market it is necessary to build a strong domestic base which is currently lacking.

For the solar energy industry to continue to grow we must achieve economics of scale in manufacturing solar equipment. In addition we must arrive at higher levels of technological development which will make photovoltiacs more competitive in relation to other forms of energy. In order for this to occur we need to cultivate markets which will produce increased levels of capital and support the ongoing development necessary to achieve more technological advanced products.

One of the aims of the Photovoltaic Center of Excellence is to assist Massachusetts photovoltaic companies in reaching the International market. This is extremely valuable since we are currently relying on International dollars in the near term to support further development in the industry. Another point worth noting is that we face stiff competition in International markets from countries such as Japan, France and West Germany. The Japanese are making major advances in solar applications and marketing agressively overseas. In addition, they have made rapid advances in developing new solar techologies. This could seriously affect the Massachusetts photovoltaic industry unless we have the support necessary to continue to compete effectively in international markets.

The key to significant expansion of the domestic photovoltaic market is cost reduction which will make photovoltaic power more competitive in relation to traditional energy sources. Throughout the past decade the price of solar cells has fallen dramastically. In order to continue to reduce costs significant requires the continued encouragement and support of research going on in areas like Massachusetts which will lead to the development of higher efficiency solar cells and the development of lower cost materials.

For instance, amorphous silicon cells are regarded by many as a key to widespread use of photovoltaics in domestic utility power generation. They offer the potential for relatively high conversion efficiency and lower cost than single-crystal silicon cells. Our program is pursuing resarch leading to advanced multi-junction amorphous silicon alloy solar cells. This research is designed to achieve high conversion efficiency, necessary for use of photovoltaic cells by the utilities.

It is programs such as those the State of Massachusetts has adopted which will enable companies to stimulate interest among foreign businessmen and encourage technology development. This support is invaluable.

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Mr. MARKEY. Thank you very, very much.

Dr. Hatsopoulos, would you please give your testimony to the subcommittee.

STATEMENT OF GEORGE N. HATSOPOULOS

Mr. HATSOPOULOS. Mr. Chairman, I would like to say a few words about some of the most exciting activities that Thermo Electron is engaged in concerning improving energy efficiency and conservation.

Thermo Electron was one of the pioneers of what is becoming known as cogeneration technology, which is the simultaneous production of electricity and heat, mostly for industrial use. The advantage of cogeneration is that you burn the fuel once and get two outputs for that fuel. As a result, your efficiency is about twice that of conventional uses of energy.

We have installed major cogeneration systems throughout the country. They usually are of the 10- to 50-megawatt size and are used mostly by industry but also by government centers as well as small municipal utilities. As I said, the big advantage of cogeneration is that it has a much higher efficiency than conventional means of generating power and heat.

But as it turned out, there are some other advantages that recently have become overriding. Cogeneration can produce the power at half the capital cost, and an installation requires 2 to 3 years to be implemented and become operational as opposed to 8 to 12 years for large central power stations, nuclear or coal.

Over the last several years, however, we have noticed that only large firms use cogeneration because cogeneration plants require a lot of supervision and a large technical staff. Yet cogeneration could produce a tremendous advantage to small firms, ranging from very small manufacturing firms to hospitals, to community centers, to shopping centers, or even to apartment house complexes.

Now, we felt that we could reply to that need by using the latest product in cogeneration, which is a small factory-built, self-operating cogeneration system. There is a picture there on the left showing one typical installation of such a system. In a way, the intent was to make it as easy to operate as a water heater and to have it completely automatic and self-correcting. In order to develop such a system, we engaged in research activities that marry basically conventional technology with very new kinds of materials, but more important was the ability to have microprocessors run the cogeneration system automatically.

The key to the success of this system is this little box that really does everything, including controlling the output, starting the unit, shutting down the unit, or even determining any defects that may arise.

The system right now is catching on very extensively throughout the country, and gas utilities are exceedingly enthusiastic in supporting it. We have dozens of applications in small hospitals and in shopping centers across the country, but primarily on the east coast and west coast, where there is a lot of growth and a lot of demand from industries. We expect these small cogeneration sys-

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tems to have even broader applications than the major cogeneration systems, which right now account for over a billion dollars' worth of business in the United States.

[The prepared statement of Mr. Hatsopoulos follows:]

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TESTIMONY OF

GEORGE N. HATSOPOULOS
CHAIRMAN OF THE BOARD AND PRESIDENT
THERMO ELECTRON CORPORATION

TO THE
SUBCOMMITTE ON ENERGY CONSERVATION AND POWER
HOUSE COMMITTEE ON ENERGY AND COMMERCE
OCTOBER 21, 1985

Thermo Electron has, for many years, been a recognized leader in the development and application of energy conservation technologies. One of the most important aspects of energy conservation, the cogeneration of electricity and process heat, is now the fastest growing component of the company's business. Our cogeneration activities include pioneering new systems such as the large slow speed diesel project at the Hoffmann-La Roche Inc. chemical plant in Belvidere, New Jersey, the combined cycle gas turbine and dual pressure steam turbine total energy facility under construction at Miami's Dade County Government Center, a $120 million trash-to-energy plant being designed for San Marcos, California, and three recently announced wood burning electric generating units to be located in New Hampshire and Maine.

Our newest, and potentially most promising cogeneration venture is the small scale TECOGEN® packaged cogeneration system which I will discuss in some detail here today. The TECOGEN system represents a unique marriage between advanced technology and conventional hardware. This natural gas-fueled modular energy system brings to a broad range of small commercial, institutional, and light industrial users the economic advantages of cogeneration that were previously available only to large power consumers.

In effect, TECOGEN is a gas water heater that also produces electricity as a by-product. Any surplus electricity produced by the module can be sold to local electric utility companies under the favorable terms specified by the Public Utilities Regulatory Policy Act (PURPA). The design is based upon a

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mass-produced low-cost automotive engine, modified to achieve extremely long life. Other standard components of the system include heat exchangers, pumps, generator, and switch-gear.

In a conventional water heater, fuel burning at temperatures greater than 2,500°F produces only low-grade energy - 150°F to 200°F hot water. Such water heaters don't make full use of the high-grade energy in the fuel; and because they are thermodynamically wasteful, they waste money, as well.

In the TECOGEN module, high-temperature combustion produces both hot water and electric power. Thermal performance is comparable to conventional water heaters, but, in addition, a portion of the fuel's energy is converted into high-grade electrical energy. The combined electrical and heating efficiency is over 83 percent. Utilization of the fuel's energy potential, both high-grade and low-grade, is maximized so that the TECOGEN module can produce electricity and hot water at a price that is often less than that of purchased electricity alone. In many applications, particularly here in the Northeast where power costs are among the Nation's highest, packaged cogeneration units can pay for themselves in less than two years, (e.g., Hartford YMCA - 2 units in photo).

A key element of the TECOGEN concept, one that is crucial to its economic viability, is the special micro-processor-based controller, (see hardware at meeting). The remarkable cost and performance improvements occuring in micro-processor technology over the past decade have made it possible to incorporate extremely complex control, monitoring and diagnostic functions in this low-cost compact package, thereby obviating the need for manual supervision of small scale energy systems. Without such modern technology, on-site cogeneration could not be cost-effective below several thousand kilowatts rating. TECOGEN, by contrast, is highly attractive for sites requiring as little as 60-kilowatts of electric power.

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Another important contributor to TECOGEN's low operating cost is the incorporation of modern metallurgical technology in critical engine components. By modifying the standard engine's valve and valve seat construction, we have extended engine life more than ten-fold. In fact, the running time between overhauls has been increased from less than 1,000 hours to over 12,000 hours, at an added cost of less than $100 per unit - a dramatic example of the leverage that can be gained through new technology.

Packaged cogeneration units are not only efficient in terms of energy consumption, they also afford a highly effective utilization of scarce capital. With an installed cost averaging only $1,000 per kilowatt, including all electrical and hot water producing componets, TECOGEN modules can be deployed for less than half the cost per kilowatt of conventional coal or nuclear powerplant capacity.

Due to its quiet operation and low exhaust emissions, TECOGEN can be installed in congested areas and in close proximity to occupied building space. Recently, for example, two units were ordered by the Downtown Athletic Club for their facility in Manhattan. TECOGEN units are already operating in schools, hospitals, hotels, laundries, food-service facilities, small industries, health clubs, and various other customer sites in California, Hawaii, the Midwest, and the Northeast. Performance and reliability have been demonstrated in over 160,000 hours of field operating experience.

Sales and service networks are already in place to serve key markets. Our own direct-marketing program is complemented by a rapidly growing effort within the gas utility industry to promote packaged cogeneration. Nearly a third of the TECOGEN units sold to date were purchased by gas utilities seeking to promote wider use of gas-fired cogeneration. Southern California Gas, Bay State Gas and Essex County Gas in Massachusetts, Connecticut Natural Gas, Southern

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Connecticut Gas, Peoples Natural Gas in Iowa, and Brooklyn Union Gas have initiated programs to own, operate, and promote TECOGEN units within their service areas.

The gas industry is also sponsoring the collection of data on TECOGEN units now in service, and the Gas Research Institute (GRI) is supporting a series of technological refinements aimed at further enhancing the performance and economics of TECOGEN. This project includes development of a system whereby the hot water output is used to drive an absorption type air conditioner.

Many potential users of on-site cogeneration equipment do not have the necessary technical expertise or financial resources to install and operate their own systems. As a result, we have seen the emergence of third-party contractors who specialize in installing, operating, and financing such systems. Such energy services companies are, in effect, "micro-utilities." They purchase fuel from a gas utility and sell hot water and electricity at a discount to end-users such as schools, hospitals, or public buildings. The energy consumer does not have to invest his own funds in the equipment and is relieved of all maintenance and repair responsibility.

An example of the third-party approach to packaged cogeneration development can be seen at Northwood Institute, a business college serving 1,800 students at its complex of 24 buildings in Midland, Michigan. In 1983, energy represented an annual cost of $300 per student and the school faced a 50 percent electric rate hike because of cost overruns for the long-delayed nuclear power plant of Consumers Power Company. Concerned about the impact of future energy costs on tuition fees, Northwood contacted Decker Energy International (DEI), a leading energy services company.

DEI's studies revealed that the school offered excellent prospects for cogeneration, due to its large and reasonably steady demands for electricity and

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heat. The campus had small boilers providing space heating, domestic hot water, and swimming pool heating at six separate locations. No single location had enough heat demand to justify installing a conventional diesel cogeneration plant, and the cost of a hot water distribution system to connect the various buildings was deemed prohibitive.

TECOGEN units provided the ideal solution because individual modules could be located in close proximity to where the heat is required. Detailed energy balances showed that two TECOGEN units could be placed in a boiler room serving two dormitories, an administration building, and the cafeteria. A third unit would serve a sports complex consisting of a swimming pool, tennis courts, and basketball arena.

This system, delivering a total of 180-kilowatts of electricity and 1.3 million Btu per hour of hot water, provides approximately 46 percent of the electricity and 40 percent of the thermal needs for the Midland campus. Northwood continues to be connected to the Consumers Power system and will keep its existing boilers in operation to meet peak demands and provide backup sources of heat.

The installation was completed in early 1984 -- less than five months after signing an energy-supply contract. Under the terms of this agreement, Northwood will purchase electricity from Decker Energy at a discount below the prevailing rates charged by Consumers Power, and will purchase hot water at a price equal to the cost of producing it in their own boilers. The system, installed at no cost to Northwood, will be owned, operated, and maintained by DEI.

TECOGEN's standardized 60-kilowatt module design provides cogeneration-system planners with extraordinary flexibilty for serving widely dispersed thermal loads, e.g., multiple buildings or widely separated wings of a large structure. Other benefits of standardized design include reduced

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manufacturing and service costs and increased reliability, particularly where several units are installed in parallel at a single site. For applications requiring up to several hundred kilowatts, the greater reliability of using multiple 60-kilowatt packages instead of a single large system can reduce significantly the demand charges incurred by electricity consumers.

Even the brief shutdown of a cogenerator's single unit cogeneration plant will cause a large short-term increase in the power supplied through the utility meter. With multiple TECOGEN units, the cogenerator can avoid total shutdown of all engines at the same time, thereby avoiding demand surges which result in sharply higher monthly charges for "one-time" peaks. Such demand charges are becoming an increasingly important component of electricity bills, especially in those regions where the enormous capital costs of nuclear power plants are now beginning to affect utility rates.

The compelling advantages of small-scale packaged cogeneration systems -- low capital cost, high energy efficiency, and short lead time -- all point to a bright future for this new cogeneration technology. A recent report by the consulting firm, Frost and Sullivan, has projected a multi-billion dollar market for such systems by the 1990's. As more experience is gained, it is possible that still smaller packaged units will become feasible, thereby bringing the economic advantages of modular cogeneration to individual home owners.

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Mr. MARKEY. Thank you very much.

Our next witness is Miss Laura Dubester, director of the Center for Ecological Technology in Pittsfield.

STATEMENT OF LAURA DUBESTER

Ms. DUBESTER. Thank you, Mr. Chairman.

I think our organization was named by an engineer and doesn't really adequately say what we do. We are a community group, a grassroots organization in Berkshire County. I think it is important that what we do has really bridged the gap between the scientists, the policymakers, the legislators, and has really provided education, direct technical assistance, dissemination information, and work to make these technologies available and affordable to the people in Berkshire County and western Massachusetts.

I am going to summarize my testimony here. Basically we began——

Mr. MARKEY. Let me make this point, that all of your written testimony will be included in the record in its entirety. We appreciate your willingness to foreshorten it to facilitate the committee's business.

Ms. DUBESTER. Good. I think my main point is that community groups have made a very important contribution toward the implementation of energy conservation and renewables throughout the Commonwealth and the Nation, and also that it is extremely important to foster the development of a more extensive and better coordinated delivery system which utilizes community groups. I think one of the most difficult things is to understand that energy conservation really depends on the millions of decisions made by the millions of people every day, and to facilitate that happening can best be done by local groups helping make this happen.

CET was founded in 1976 during the energy crisis and then really was very much supported during the Carter administration. But in 1980 we really had to brace ourselves for the reversal of national energy priorities and most groups like us didn't survive this change in policy and funding. In Massachusetts, Proposition 2½ further strained local governments. As a result, really, over the last 4 years I think there has been a real problem trying to get the policies we want to get implemented, working at the community level. Energy plans sit on the shelf and local governments really can't make energy a priority. Often citizen involvement has really dissolved and community groups have folded.

Other aspects of energy have been institutionalized by utilities, community action agencies, and by government. In fact, this really has further drained the community groups which were the pioneers and the innovators in the whole movement. A lot of people in community groups maybe went to the utility companies for more secure and better paying jobs and drained the grassroots organizations of more of their leadership.

An example of this would be the RCS or the Residential Conservation Service Program which, in essence, in 1980 became the largest program—$8 million approximately in Massachusetts—which had no involvement of community groups. Whereas in 1976 and 1977 audits were being performed by the cooperative extension

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service and grassroots organizations throughout Massachusetts at least.

Despite all these adverse circumstances, some organizations have managed to endure these changes. We are more than ever convinced of our ability to make innovative and positive contributions to the overall effort of energy conservation. I think, fortunately, there is a real positive trend in this direction. In fact, the abilities and effectiveness of groups like CET is now achieving recognition. The executive office of energy resources I think understood this when it designed the Energy Conservation and Solar Bank Program, where they designed it for implementation by community groups.

As you know, this energy program was initiated by Senator Tsongas and basically slated for extinction by the Reagan administration which finally began in 1983. We have been really tracking it since 1978 and are very convinced that if we could finally get this program we could make it work and could really make a difference. Prior to this program we had hypothesized that the obstacle to implementation of energy improvements at the household level was not only due to the lack of financing but also the absence of the related arranging services.

I think this program overcomes all these obstacles. For example, in Berkshire County, the CET staff meets with clients to review the audits; we provide clients with a list of State-approved contractors; we review selected estimates for thoroughness; we inspect the completed work to make sure the anticipated energy savings will be achieved; and in the case of problems, we help mediate solutions.

This comprehensive approach has resulted in over $1,500,000 in improvements in Berkshire County alone. Also, it is reaching the target groups. Approximately 40 percent of the beneficiaries of this program are tenants; 20 percent are elderly, and 8 percent female head of household. Over 50 percent of our clients earn less than 80 percent of the median income. I think what is even more impressive is that one program has now reached 1 percent of the entire population of Berkshire County, which, I think, proves again that energy conservation is marketable, you can design programs that work, and you need a group that is committed and dedicated and can help make those policies the way you intend them actually happen.

Another indication of the trend toward recognition of community groups is the fact that the largest utility in eastern Massachusetts has recently contracted with a nonprofit comprised of other nonprofits to provide its RCS energy audits. Mass Electric, or MECA, has become the first utility to agree to serve as a lender for the Energy Conservation Loan Program in conjunction with its new pilot program in the economically depressed areas of Berkshire County.

Other initiatives that community organizations have taken are forming a federation where we can buy weatherization materials wholesale and then sell them to ourselves or housing authorities or community action agencies, again making sure we have quality materials purchased through a fair and competitive bidding process. We have purchased now about half-a-million dollars in weatherization materials a year. We also have about 9,000 to 10,000

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households currently involved in oil cooperatives, especially in the eastern part of the State.

So these are a few of the successes. Obviously, the problem continues to be the lack of Federal support for energy conservation and renewable resources. In the absence of this leadership and support, it is imperative for the State and local communities to identify those problems which we can solve without Federal support. But, I think, most important, and the one way you can help us, would be looking closely at the now oil overcharge moneys which hopefully will be coming down to the States in the next year, and especially what kind of restrictions will be placed upon them. Right now, the major restrictions are they can't be used to purchase weatherization materials, which is precisely what is most needed. So here again is that ironic standard of what you can do with the money that is intended to work for energy conservation.

Those are my basic comments. Thank you.

[The prepared statement of Ms. Dubester follows:]

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TESTIMONY

"Massachusetts Energy: Innovative Models for the Nation"

By: Laura Dubester, Executive Director
Center for Ecological Technology (CET)

I would like to talk about the contributions of the Center for Ecological Technology (CET), a non-profit energy organization in Berkshire County, in tackling energy issues. I also will discuss the need to foster the development of a more extensive and better coordinated delivery system which utilizes community groups in all stages of policy planning, program design and implementation.

Founded in 1976 during the energy crisis, CET educates people about energy conservation, weatherization and renewable resources; encourages citizens to become involved in energy and resource issues; and makes conservation and renewables available and affordable to low and moderate income residents of western Massachusetts through dissemination of information, energy financing and direct technical assistance.

CET, like many other community organizations has had a precarious existence. From 1977 - 1980, community groups were pioneering energy education and programs. For example, CET (and the Cooperative Extension Service) provided the first energy audits in Massachusetts. CET provided over 1,000 audits, performing heat loss calculations with a hand-held calculator, and did this in conjunction with CETA -- teaching unemployed people a new field and vocation.

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During the Carter administration, energy conservation and the development of renewable resources became a national priority, and many new initiatives were carried out at the local level. For example, Project SUEDE, a federally funded solar demonstration project provided low-cost solar space heating to low income households and trained unemployed people about energy theory and construction. The DOE Small Grants Program enabled individuals, organizations and businesses to apply for funds to develop or try out technically sound innovative energy saving projects.

In 1980 we braced ourselves for the reversal of national energy priorities. Most groups did not survive the radical change in energy policy and funding. In Massachusetts, the passage of Proposition 2½ further strained local governments. The subsequent oil glut also fed the perception that the "energy crisis is over". People have been expected to "adjust to higher energy costs" or solve their problems on their own through the market place. As a result, energy plans sat on the shelf; local governments no longer gave energy the attention needed; citizen task forces dissolved; community groups folded and people and businesses suffered! The beginning of the "institutionalization" of energy programs by the utilities and government further drained the community groups. For example, when energy audits were "institutionalized", through the Residential Conservation Service - RCS - Program, the new 8 million dollar state program financed through the rate base had no community group involvement. Many talented people from the "grassroots energy groups" moved to higher paying and more secure positions within the utility structure.

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Despite these adverse circumstances, some organizations did manage to endure these changes, and we are more than ever convinced of our ability to make positive contributions to the overall effort of energy conservation. I would like to site some of CET's accomplishments over the last several years:

CET has conducted over 120 technical workshops in such areas as solar greenhouses, windpower, energy efficient design, window insulation and solar hot water. Over 50 workshops have been conducted for low-income households distributing low-cost weatherization kits. CET has assisted over 400 seniors in making at least one room in their homes draft-free and providing counseling and information about the risk of hypothermia; CET has conducted energy audits for 9 towns and has trained over 40 young people in conservation theory and weatherization practices. CET has coordinated programs of technical assistance to energy intensive industries and small businesses in Western Massachusetts.

Fortunately the unique abilities and effectiveness of community groups in providing direct services is finally achieving recognition. The Executive Office of Energy Resources (EOER) understood this when it designed the Energy Conservation and Solar Bank Program for Massachusetts. This energy financing program, initiated by Senator Tsongas and scheduled for extinction by the Reagan administration in 1980, began only as a result of a long court battle. Prior to this program we had hypothesized that the obstacle to the implementation of energy improvements at the household level was due to not only the lack of financing, but also the absence of related arranging services. This program

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overcomes all these obstacles. CET staff meets with clients to review the Mass-Save energy audit; we provide clients with a list of state approved contractors; we review the selected estimates for thoroughness; we inspect the completed work to make sure the anticipated energy savings will be achieved; in the case of problems, we help mediate a solution.

This comprehensive approach has resulted in over $1,500,000 in improvements in Berkshire County alone. Monies spent on energy conservation remain in the community, paying local contractors and suppliers and improving the housing stock. The energy savings is then available for spending on other needed goods and services. Approximately 40% of the beneficiaries of this program are tenants; 20% elderly and 8% female head of household. Over 50% of our clients are less than 80% of the median income. These statistics indicate that this program IS reaching the people who need help the most. This is especially satisfying and again disproves the myth that people won't borrow for energy improvements or that banks won't loan money to lower income people. This program has now benefitted approximately 1% of the total number of households in Berkshire County.

EOER has also begun another program called Mass-Rise. Through Mass-Rise, CET can provide flyers, booklets and in-person assistance to people seeking information about renewable resources.

Another indication of the trend toward the recognition of community groups is the fact that Massachusetts' largest electric utility has recently contracted with Community Energy Partnership (CEP), an organization comprised of non-profit groups, to provide the RCS audit services to its customers. Other utilities are beginning

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to cooperate and coordinate more with the on-going work of community groups.

Community organizations have also created ways to prevent "competition amongst ourselves for a smaller piece of the pie", understanding that this strategy would ultimately be destructive to the organizations and those we serve. Instead we have attempted to increase our level of cooperation to develop new initiatives. For example, CET and four other non-profits created a new organization, The Energy Federation, to accomplish several goals: (1) to share information, both technical and programmatic; (2) to provide quality weatherization materials at low prices through a fair and competitive bidding process; (3) to have input into state and federal energy policies. EFI has been extremely successful, with sales of approximately one-half million dollars yearly to ourselves, housing authorities, community action agencies, and individuals. Other states are now seeking to replicate the EFI model. Other examples of a successful initiative of local groups are the oil cooperatives especially prevalent in eastern Massachusetts. Over 9,000 households are now members of oil coops!

Despite our successes, the lack of federal support for energy conservation and renewable resources continues to be a huge obstacle to the task at hand. However, in the continued absence of federal leadership and support, it is imperative for the state and local communities to identify those problems which can be solved without federal support, and to develop appropriate long and short-term strategies to solve them. Hopefully, it will not take another "energy crisis" for our senators and representatives to realize that energy conservation and the development of renewable resources is the most sound policy, from the economic perspective as well as to protect our national security. Thank you very much.

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Mr. SIKORSKI [presiding]. Thank you.

Our next witness is Mr. Paul Wormser, who is with the Mobil Solar Energy Corp. Is this your operation here?

STATEMENT OF PAUL WORMSER

Mr. WORMSER. It will be, as soon as I turn it on.

Mr. SIKORSKI. It was working before.

Mr. WORMSER. I wanted to save the surprise.

Mr. WORMSER. Thank you very much, Congressman.

The main point that I want you to go away with today is that photovoltaics work. Photovoltaics, in my biased opinion, are beautiful, and I hope that I can give you that same bias with a demonstration.

Photovoltaics are cost-effective today in certain applications, and as the cost of photovoltaic systems is reduced, photovoltaics will become cost-effective in other applications, including utility generation. Photovoltaics can play a major role in the U.S. energy supply. The United States is currently the world leader in manufacturing photovoltaic modules and systems.

Let me show you a little bit about photovoltaics. This is a photovoltaic module. It is lightweight. It is solid state, never wears out. It needs no maintenance. It converts sunlight into electricity so that if we have some sunlight we can get electricity and my little motor will operate. If we take the sunlight away, my motor will not operate.

Mr. SIKORSKI. How does that stand up to rain, snow, and hail and all that?

Mr. WORMSER. Photovoltaic modules incorporate solar cells and are usually a covering of tempered glass with a hermetic seal on the back, so that weather does not get into the solar cells. We determined it will have a useful lifetime of 20 to 30 years, possibly longer.

As an additional demonstration of photovoltaics, you can use photovoltaics to pump water which today is a very cost-effective application in certain parts of the world. If you have water 20 feet below the ground, and you're in a remote area and you want water, you can put in a simple photovoltaic system and get water. The brighter the sunlight, the more water you'll get. You'll start in the morning with perhaps a trickle. As the Sun comes up during the day, you will get more water. In the afternoon, as the Sun goes down, you will get less water.

Photovoltaics have no ability to store energy. However, you can store the electricity, if you need to, in the form of pumped water storage, which is actually done by some of our utilities, or you can store photovoltaic electricity in a rechargeable battery. You put it in there during the daytime and take it out whenever you wish.

Photovoltaics are beautiful.

[End of demonstration.]

Mr. SIKORSKI. I think now we're going to have to have a shift here and play musical chairs, if the rest of the panel could come forward. Then we will have questions for all nine of you.

Mr. Goldner, I think we'll begin with you. Mr. Goldner is professor of electric engineering at the Electro-Optics Technology Center

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at Tufts University. I'll reaffirm what the chairman said with regard to statements being put in the record in total. Please summarize as best you can.

STATEMENTS OF RONALD B. GOLDNER, TUFTS UNIVERSITY ELECTRO-OPTICS TECHNOLOGY CENTER; E. STEPHEN MILIARAS, MANAGING DIRECTOR, ENERGOTECHNOLOGY CORP.; MARK B. FORTIN, MANAGER, MECHANICAL ENGINEERING, U.S. WINDPOWER, INC.; AND J.J. BRIODY, SENIOR VICE PRESIDENT, INDUSTRIAL/COMMERCIAL DIVISION, NORTH AMERICAN PHILIPS LIGHTING CORP.

Mr. GOLDNER. Thank you, Congressman Sikorski. Also, I would like to thank the committee in general, and certainly the chairman, for inviting us to be a witness for you. I would also like to commend Chairman Markey on his long-range views on energy conservation, certainly in research and development, as well as education. This hearing today, I think, is a good example of the education aspect.

Being a professor, I have a hard time not standing up, so I hope you will forgive me for that.

The discussion I would like to briefly have with you is this: I would like to show to you what a "smart window" is based upon, what the electrochromic effect is, which is the basis for smart windows, and then I would like to discuss with you the importance of smart windows or electrochromic windows, and then I will try to anticipate some questions you may have and certainly at the end of our panel discussion will try to answer any other questions you may have.

To begin with, let me demonstrate what electrochromism is. This is a laboratory-type of apparatus so it is small, but I think it will prove the point.

Mr. SIKORSKI. Do you have the death penalty here in Massachusetts?

Mr. GOLDNER. Do we have the death penalty in Massachusetts? No, we don't, thank goodness.

Mr. SIKORSKI. Good.

Mr. GOLDNER. However, we're talking about batteries which are the same size as you use in your flashlight. This low a voltage would certainly not electrocute anybody. I think that's an important point.

If you look at this very small window, you will see it is quite blue at the moment, and it is becoming more blue. If I reverse, you will see it bleach, becoming less blue. In reversing the current flow it becomes blue again. What you are seeing now is, with the passage of a very small amount of current, that is charge transfer, I can easily change the color of the window.

You have in front of you three examples of windows that have been colored months ago, the point being that they retain their state of coloration. To show you some contrast, here is one that has half of it colored and the other half not colored.

Let me indicate to you the importance of this effect in the form of how one might use electrochromic windows with these diagrams. I am going to illustrate the ideas with four typical applications

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that one might consider: a day in the winter, a day in the summer, a night in the winter and a night in the summer.

Let's consider the daytime use in the winter. When we have a sunny day, we have the temperature outside considerably less than inside. We have the sun shining on our building. At that particular moment we would like to let in as much of the sunlight as we could. In the bottom part of the diagram, you can see the solar spectrum. At the same time, however, we would not like to let out what we call the thermal infrared; that is, the heat that you and I emit. Therefore, we would like to have a reflectivity, which is a function, a step-like function, so that we reflect all the heat from within, hold it within the building, as you can see indicated by this diagram. In this way we have captured all the energy and we have saved it.

On the other hand, in the summer, we would prefer to have as little of the sunlight coming in to decrease the cooling load in the building. So what we would like to do is reflect away as much of this thermal infrared part of the solar spectrum. That is indicated by this step function, moving over to where it's red now and permitting only that portion of the sun that we use for daylighting, so that we do not have to turn on the electric lights and further add to the cooling load of the building.

On the other hand, at nighttime, we would like to have none of the radiation in the winter leaving the building. We would like to keep it all inside. So we would like to completely reflect all the radiation. And vice versa, in the summer at night, we would like to let all the radiation out of the building, to try to keep the cooling load down again. So here are four typical applications for buildings that are rather important.

Finally, there is another application which every one of us I think has experienced, and that is, when you're driving your automobile and you park it in the sunlight, and you come back an hour later and you open the door, it is exceedingly hot inside your automobile. In fact, you can burn yourself because temperatures inside the interior of an automobile can reach about 200 degrees Farenheit. So not only can you get burned but you can also damage the materials on the interior of your automobile.

The cooling load that this puts on the air conditioner of today's automobiles is considerable. Again, if we had a smart window on our automobiles, when we left our car parked in the sun, we could then switch it so we would let none of the sunlight into the car. At the same time we have gained a certain amount of privacy for the automobile so that we can leave goods in the car without people seeing them.

Let me briefly discuss the importance of smart windows from an economical viewpoint. The energy it takes to control the climate of buildings in the United States is roughly one-third of the national energy budget, which is roughly $500 billion. That means we're talking about $165 billion or more. Of that, approximately $30 to $50 billion is literally thrown out the window; it is wasted. The major energy loss in buildings is through the windows, and we're talking about $30 to $50 billion a year. That is equivalent to something like the energy produced annually by more than 50 powerplants of about 1,000 megawatts capacity, or one Alaskan pipeline

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as somebody pointed out—that is, the energy from the Alaskan pipeline. I think these numbers speak for themselves.

You might ask how much it will it cost to operate these windows. After all, you just saw me operating it with a battery. These are 1.5-volt batteries, or 3-volt batteries that we're talking about. That's the kind of voltage one needs. If you ask how much energy it takes, you will find that if you switched 10 windows within a building five times a day, roughly the cost of the amount of energy consumed is equivalent to something like 1 cent a day. That is less than one-hundredth the cost of the energy lost through the windows.

Let me conclude my remarks by reading from my testimony. The smart windows research is just one of several education and research activities in which the Tufts Electro-Optics Technology Center is involved that we think is very important for both the near-term and the long-term economic health of not only Massachusetts but of the Nation. Through team teaching, with renowned persons from industry, Government, and universities, we are engaged in educating a number of today's and tomorrow's leaders. These same people should be able to communicate and provide mature decisions not only that would lead to the rapid development of smart windows and the commercialization of such products, but also for other areas of energy conservation and production.

Finally, the Electro-Optics Technology Center is beginning to serve as another Massachusetts model for innovative education and relevant research, especially in energy, that will be emulated elsewhere in the Nation, if not in the world. We are pleased to have assisted in the establishment and nurturing of such a model center that is supplying the sorely needed short and long range imaginative education and research for endeavors not only for smart windows but for other areas that are important for the well-being of all of us and our posterity.

Thank you.

[The prepared statement of Dr. Goldner follows:]

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SMART WINDOWS

Professor Ronald B. Goldner
Tufts University Electro-Optics Technology Center

Congressman Markey: I should like to thank you and your staff for having provided us with the opportunity to testify about energy conservation, and particularly smart (or electrochromic) window research, which has been supported by the Department of Energy for several years, at the Tufts University Electro-Optics Technology Center. I should also like to point out that during the past decade it has been the vision, encouragement, and leadership of two individuals, Fred Morse and David Pellish, both of the Department of Energy, that has been primarily responsible for the modest, but exceedingly valuable national research program on building science of which our solar energy research is a part; and which I believe will be of immense long-range importance for the economy of Massachusetts, New England, and the Nation.

To appreciate the use of a smart window, consider a cold, sunny winter day and a hot, sunny summer day as 2 typical situations. During the winter day, to decrease the heating and lighting loads of a building the window will most likely be switched to a highly solar-transparent ("bleached") state, allowing for high solar energy input (solar gain). On the other hand, during the summer day, to decrease the cooling load without reducing daylighting, the window will probably be switched to a visibly-transparent ("partially-colored") state, thereby lowering solar gain, but providing daylighting. These reductions in heating, and cooling loads, and artificial lighting requirements are very important for the following reasons.

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In the past decade, energy consumption has reduced in almost all sectors except the buildings sector where the trend has been that of increased consumption. In particular, currently, more than one-third (1/3) of the national annual energy budget (greater than $500 billion) is associated with controlling the climate (i.e., heating, cooling, and lighting) of the more than 80 million buildings (residential and non-residential) in the United States; and this fraction is growing. This represents more than $165 billion. A significant fraction of that energy is literally, "thrown out the window;" i.e., unnecessarily wasted through windows. One estimate of the amount of energy wasted is that it represents the energy output of more than 50 typical (approximately 1000 MW) electric power plants, or one Alaska pipeline, or a loss of greater than $30 billion (and probably closer to $50 billion), annually. A large amount of this energy wasted is lost by radiant energy transfer (in either direction) through the windows. Fortunately, smart windows can stop almost all that energy from being, "thrown out the window."

During this same past decade of increased energy consumption in buildings we at Tufts have been doing, and are continuing to do, basic optics and materials research aimed at reversing the trend of increased building energy costs and/or energy consumption; and, in the past 3 1/2 years we have been at the leading edge of fundamental research that will lead to the development of smart windows in the near future. In fact, in close cooperation with a

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team of researchers under Drs. R. David Rauh and Stuart Cogan, of EIC, Inc., Norwood, Massachusetts, we have begun work on many of the practical problems that will be associated with the manufacture of electrochromic, or smart, windows; and the manufacture and installation of such windows will be of major importance to the building industry and the economy as a whole. This is in addition to the fact that smart windows will be able to significantly reduce the energy wasted in buildings by providing major decreases in heating, and cooling loads, and artificial lighting requirements in buildings.

Smart windows will allow for low-cost, automatic electronically-controlled, spectrally-selective, radiant energy transfer during a 24-hour day. Such automatically controlled energy transfer can eliminate the need for constant human attention and intervention, which is especially important in non-residential buildings.

Vehicles, such as automobiles and aircraft are also in need of controlled radiant energy transfer for energy conservation. For example, customers continually demand more window area for viewing safety and for comfort, thereby exacerbating the heating and, especially, the cooling load problems: the increased solar energy that enters through larger windows makes it virtually impossible to provide adequate cooling in automobiles with air

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conditioners powered by small, fuel-conserving engines, particularly in the U. S. Southwest. Furthermore, temperatures inside parked cars left in bright sunlight can exceed 200 degrees, which not only places an enormous cooling load on air conditioners, but also causes severe damage to materials in the vehicle interior. Once more, smart windows can largely solve these problems (as well as be able to provide privacy in parked cars, for security reasons).

At present there are a few other laboratories around the world doing smart windows research. These include, in addition to Tufts, 3 other laboratories also supported by the Department of Energy: EIC, Inc. in Massachusetts, the Solar Energy Research Institute in Colorado, and the University of California, Lawrence Berkeley Laboratory. And there has been an intensive R & D effort in Japan, especially by the Asahi Glass Company, who have announced that within the next year they will bring to market the first electrochromic window type devices.

The type of smart window structure on which we are doing research is an all solid-state electrochemical cell which is comprised of 3 basic thin film layers: an optically-active electrochromic layer, which conducts both electrons and ions; an ion conducting layer, which conducts only ions; and an optically-inactive (or an optically-active complementary-

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electrochromic) counterelectrode layer, which conducts both electrons and ions. Such a smart window can have its spectral selectivity (optical filtering) continously and reversibly varied from a completely solar-transparent ("bleached") state, through an only visible-transparent ("partially-colored") state, to an opaque ("colored") state, and vice versa, by the passage of a relatively small electrical current. The current direction and amount of charge transferred (integrated amount of current) determines the state of "coloration." The passage of the electrical current allows for the injection or extraction of electrons and charge compensating ions (e.g., hydrogen, lithium, sodium) into the electrochromic layer (e.g., tungsten trioxide, WO_3). The electrochromic layer reversibly "colors," or "bleaches," respectively, depending upon whether electrons are injected or extracted. This is because the optical properties are determined by the interaction between light and electrons and, consequently, the modulated electron population will, in turn, modulate the optical properties. The time required to switch from the "bleached" to the "colored" state can be in the vicinity of a minute; and a one square meter (approximately 10 square ft.) window would require approximately 2 watt hours of energy to be so switched. For a residence of 10 such windows, switched 5 times per day, the energy consumption would be 0.1 kWh, which, at 10¢ per kWh, would cost 1¢ per day, approximately 100 times less than the cost of the energy typically lost through ordinary windows.

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As a result of our fundamental studies, we at Tufts, in cooperation with EIC, Inc., have come up with several important theoretical and experimental breakthroughs on each of the layers of the smart window which, we optimistically predict, will lead to the development of high-quality, practical smart windows in the near future.

Finally, let me add a few closing remarks. The smart windows research is one of several education and research activities in which the Tufts Electro-Optics Technology Center is involved that are important to the near-term and long-term economic health of Massachusetts, New England, and the Nation. In brief, through team-teaching, with renowned persons from industry, government, and universities, we are engaged in educating a number of today's and tomorrow's leaders. These persons will have the confidence, experience, and good judgement, (gained from a strongly laboratory-based, relevantly-focused, graduate-level education), to make and communicate responsible and mature decisions (in industry, government, and universities). Such decisions will lead to the rapid development and commercialization of smart windows and other devices, systems, and ideas useful not only for energy conservation and production, but for many other areas of human endeavor. These include: health care and delivery, earth resources monitoring and management, entertainment, fiber optics communications and sensors, computation, and almost every imaginable area of science and engineering.

The Electro-Optics Technology Center is beginning to serve as another Massachusetts model for innovative education and relevant research (especially in energy) that will be emulated elsewhere in the nation if not the world. We are pleased to have assisted in the establishment and nurturing of such a model center that is supplying the sorely-needed short- and long-range imaginative education and research for endeavors such as smart windows development which are important for the well-being of all of us and our posterity.

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Mr. MARKEY [presiding]. Thank you very, very much. That was very interesting testimony.

Our next witness is Mr. Stephen Miliaras, who is the managing director of ENERGO Technology Corp. of Cambridge, MA.

STATEMENT OF E. STEPHEN MILIARAS

Mr. MILIARAS. Mr. Chairman, members of the subcommittee and the panel, ladies and gentlemen. I welcome the opportunity to address the subcommittee during this field hearing. I do not want to sound a sour note; however, at this time of euphoria on energy issues, I see trouble ahead. That is why I have entitled my remarks "Cogeneration—The Pitfalls and the Opportunities."

First, the pitfalls. Jimmy Carter, our engineer President, in his second State of the Union Address, highlighted the many benefits of cogeneration. Subsequently, Congress enacted PURPA and the Supreme Court affirmed its constitutionality.

A forward cogeneration policy was a Carter administraton contribution that restored our energy independence and helped bring about economic recovery—one of several such contributions that are pointedly overlooked, even by members of his own party.

Before Mr. Carter's cogeneration message, and after PURPA, engineers have been selling cogeneration to plant managers. However, not unlike Mr. Carter, they have been generally poor salesmen—with the exception of Dr. Hatsopoulos, of course. We now find cogeneration being successfully sold, often oversold, by investment counselors, and tax lawyers on the strength of the tax shelter that PURPA affords to trustees of large institutions and board members of large corporations.

Naturally, under these circumstances, sound engineering and economic considerations and actual conservation potential often are given cursory, indeed, secondary consideration, after the cogeneration plant has been sold on the basis of the bottom line of a tax shelter analysis.

I am afraid that many such plants, particularly among the smaller sized—those under 5 megawatts—sold to investors in search of tax shelters by investment counselors will soon close down after opening because they will be impractical, uneconomical, or unsafe.

I assure you that tax shelters alone will not keep cogeneration plants operating, and many of them will not be around when energy shortages again appear.

What can be done about the situation? Well, certainly I am not calling for the elimination of the tax shelters available to investors through the construction of cogeneration facilities. I believe that they are necessary if the cogeneration pace is to continue. However, the Department of Energy's qualifying facility criteria are not adequate to assure the subsequent economically viable operation of the plants. I believe that some type of criteria or index of the actual fuel conservation and operating cost savings that the plant will bring about are needed. Such criteria, or the value of such an index, need not necessarily preclude the construction of the facility. However, they should be made available publicly, just as the risk of stock offerings is listed in the prospectus.

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I am certainly not calling for more regulation here but, rather, for the inclusion of simple steps in the current certification process that will reduce the need for extensive, after-the-fact regulation, to curb abuses.

Now for the opportunities in cogeneration. For Massachusetts and for many other States there is enough time left to consider such measures which will assure the construction and subsequent continued operation of sound and economically viable cogeneration facilities.

In addition, these States can take steps to ferret out and encourage real cogeneration opportunities in the public as well as the private sector. These include large institutions with daily and seasonally compatible electricity and thermal-load profiles, such as hospitals, where lights are always burning brightly, and heat, or air-conditioning is always on. Large public facilities, such as airports—of which Logan is a prime example with a 15-megawatt electric load—have similar, compatible electric-thermal-load profiles and should be encouraged to construct cogeneration facilities.

In the private sector, large industrial users of electricity and heat, as well as shopping malls, and large housing, and mixed-use complexes, should be encouraged to consider cogeneration. It is surprising, however, in view of how active the retrofit market is, that of over 50 such new developments planned or under construction in the Greater Boston Area, few, if any, are considering cogeneration. Such new developments will probably add a couple of hundred megawatts of undesirable electric load, with sharp seasonal and daily peaks, to the region's electric demand, and they will increase the need for the construction of expensive, new capacity. I suspect that what their developers will put up in linkage payments for Boston neighborhood projects will not come anywhere near to compensate for what will be taken away from Massachusetts ratepayers in embedded low-cost plant capacity.

I doubt that the elimination by DPU of the promotional electric J rate and the new time-of-day rates will be effective in curtailing electric demand, as the new rates will burden the eventual users of the space rather than the current developers. Perhaps the Massachusetts Environmental Policy Act [MEPA] and its article on resources conservation and use can be broadly interpreted to require serious consideration of cogeneration by developers in order to curtail the projected increase in the consumption of energy by these projects. Also, the town of Hull's recent RFP for conservation considerations in the anticipated residential development and increased electric loads in the town could similarly be the forerunner of more incentives in that direction.

Finally, let us not overlook the need for trained personnel to operate and oversee these facilities. There is a need to develop programs for training at the State's community colleges.

I would finally like to add that we heard from various speakers as to the dispersed technologies such as cogeneration, solar, and windpower, how they can reduce the cost of electricity. Unfortunately, there is no way to get away from large plants. There is a need to find some way to reduce the cost of building them. I believe that the current program on clean coal combustion technology that Congress has funded offers such opportunity.

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Generally, progress in technology in this country has come from the smaller companies. However, the smaller companies may be excluded from the clean coal technology funding because of the requirement for cost sharing which the smaller companies cannot afford. So some way has to be found to assure that the smaller companies can participate in the clean coal technology funding.

Thank you very much.

[The prepared statement of Mr. Miliaras follows:]

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Statement of

E. Stephen Miliaras, Managing Director

ENERGOTECHNOLOGY CORPORATION, CAMBRIDGE, MASSACHUSETTS

before the

SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

of the

HOUSE COMMITTEE ON ENERGY AND COMMERCE

Boston, Massachusetts, Monday, October 21, 1985

Mr. Chairman, Members of the Subcommittee and the Panel, Ladies and Gentlemen: I am Stephen Miliaras of Energotechnology Corporation, here in Cambridge, a company I organized ten years ago, continuing a career in the energy and power generation fields that now spans over twenty-five years. At the time, a quick check of the telephone directory to see if the prospective name of the company was available disclosed only one other company with a name beginning with 'energy;' that was the Energetic Lingerie Company--also in the Kendall Square area of Cambridge. Now, of course, there are two dozen such companies listed in the Boston area telephone directory.

I welcome the opportunity to address the subcommittee during this field hearing. I do not want to sound a sour note; however, at this time of euphoria on energy issues, I see trouble ahead. I have, therefore, entitled my remarks: COGENERATION--THE PITFALLS AND THE OPPORTUNITIES.

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First, the pitfalls.

Jimmy Carter, the engineer president, in his second State of the Union address, highlighted the many benefits of cogeneration. Subsequently, Congress enacted PURPA, and the Supreme Court affirmed its constitutionality.

A forward cogeneration policy was a Carter administration contribution that restored our energy independence and helped bring about economic recovery--one of several such contributions that are pointedly overlooked, even by members of his own party.

Before Mr. Carter's cogeneration message, and after PURPA, engineers have been "selling" cogeneration to plant managers; however, not unlike Mr. Carter, they have been poor salesmen. We now find cogeneration being successfully "sold"--often oversold--by investment counselors and tax lawyers on the strength of the tax shelter PURPA affords to trustees of large institutions and board members of large corporations. They are invited to participate in third party financing and leasing arrangments of the cogeneration facilities and share in the tax shelter largesse.

Naturally, under these circumstances sound engineering/economic considerations and actual conservation potential

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often are given cursory, indeed secondary consideration, after the cogeneration plant has been sold on the basis of the "bottom-line" of a tax shelter analysis.

I am afraid that many such plants, particularly among the "smaller sized" (under five MW), sold to investors in search of tax shelters by investment counselors (who in the past promoted the drilling of dry wells in Oklahoma or the raising of phantom cattle herds in Montana as similarly attractive tax shelters) will soon close down, because they will be impractical, uneconomical or unsafe.

I assure you that tax shelters alone will not keep cogeneration plants operating, and many of them will not be around when energy shortages again appear. I suspect, furthermore, that the expression "cogeneration fiasco" will soon take its place next to the expression "PURPA Machine" for the windmills which have ended up being net users (rather than producers) of electricity.

What can be done about this situation? I am not calling for the elimination of the tax shelters available to investors through the construction of cogeneration plants. I believe that the tax inducement is needed if the cogeneration pace is to continue. However, the Department of Energy's Qualifying Facility (QF) criteria are not adequate to assure the subsequent economically viable operation of the

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plants. I believe that some type of criteria or index of the actual fuel conservation and operating cost savings that the plant will bring about are needed. Such criteria, or the value of such an index need not necessarily preclude the construction of the facility, however, they should be made available publicly--just as the risk in stock offerings is listed in the prospectus.

I am certainly not calling for more regulation; rather, for the inclusion of simple steps in the current certification process that will reduce the need for extensive, after the fact regulation, to curb abuses.

Now, for the opportunities:

For Massachusetts, and for many other states, there is enough time left to consider such measures which will assure the construction and subsequent continued operation of sound and economically viable cogeneration facilities.

In addition, those states can take steps to ferret out and encourage real cogeneration opportunities in the public, as well as the private sector. These include large institutions with daily and seasonally compatible electricity and thermal load profiles, such as hospitals, where lights are always burning brightly and heat or air-conditioning is always on. Large public facilities, such as airports--of

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which Logan is a prime example with a fifteen MW electric load--have similar, compatible electric/thermal load profiles and should be encouraged to construct cogeneration plants.

In the private sector, large industrial users of electricity and heat, as well as shopping malls and large housing and mixed use complexes or clusters should be encouraged to consider cogeneration. It is surprising however in view of how active the retrofit market happens to be that of the over fifty such new developments planned or under construction in the Greater Boston area, few, if any, are considering cogeneration. Such new developments will probably add a couple of hundred megawatts of undesirable electric load (with sharp seasonal and daily peaks) to the region's electric demand, and they will increase the need for the construction of expensive new capacity.

I suspect that what their developers will put up in linkage payments for Boston neighborhood projects does not compensate for what will be taken away from Massachusetts ratepayers in embedded low cost plant capacity.

I doubt that the elimination by DPU of the promotional electric "J"rate and the new time-of-day rates will be effective in curtailing electric demand, as the new rates will burden the eventual users of the space, rather than the current developers. Perhaps MEPA (Massachusetts

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Environmental Poli-cy Acti and its article on Resources' Conservation and Use can be broadly interpreted to require serious consideration of cogeneration by developers in order to curtail the projected increase in the consumption of energy by these pro-jects. Also, the Town of Hull's recent RFP for conservation considerations in the anticipated residential developement and increased electric loads in the town, could similarly be the forerunner of more initiatives in that direction.

Finally, let us not overlook the need, as well as the potential for trained and skilled personnel to inspect , but most, important operate future cogeneration facilities properly. There is a need to develop such training and curricula at the State's Community Colleges, now. There is, of course, considerably more to be said on the subject, but I will conclude my remarks, here. Thank you.

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Mr. MARKEY. Thank you.

Our next witness is Mr. Mark Fortin, the manager of mechanical engineering for the U.S. Windpower Co. of Burlington, MA.

STATEMENT OF MARK B. FORTIN

Mr. FORTIN. I would like to thank Congressman Markey and Congressman Sikorski for holding this hearing and for inviting us to participate.

The discussion that my colleague, Bill Aitkenhead, and I have prepared this morning is in three parts. First, I would like to tell you a little bit about who U.S. Windpower is, what we do and how we're doing; second, I would like to tell you a little bit about our product and how it works; and, finally, I would like to briefly touch upon the economic and environmental advantages of generating power by the wind.

U.S. Windpower was organized in 1974 by Massachusetts businessmen with experience in starting technology-based companies. Massachusetts, with its fine, technical universities and colleges and the high-technology industry surrounding us is a great place to start a company like this and to begin a research and development activity.

U.S. Windpower has taken advantage of this and the supporting industry network to maintain some pretty impressive growth numbers. We have grown from a small research and development organization to a large, fully integrated company with over 420 employees in Massachusetts and in California.

As to the machines we build, you can see a picture here on center stage of our commercial-size wind turbines. As of September 1, U.S. Windpower has installed some 1,620 of these wind turbines. That represents an installed capacity of 131 megawatts. That equipment has produced in excess of 235 million kilowatthours of electricity, and our machines have accumulated over 4 million operating hours.

Over the last few years, the equipment is very rapidly becoming a reliable, mature product. Our fleet of 56-100 wind turbines has established a record of better than 95 percent availability for each of the last 2 years.

Our product is more than just a windmill. It's a wind powerplant. Of course, the U.S. Windpower model 56-100 wind turbine is the key component in that wind plant. The wind turbine, as you see—I may have a better picture of it over here—it is a downwind 3-bladed variable-pitch machine. It has a 56-foot-diameter rotor made up of three 28-foot-long blades. The machine operates in winds from 12 to 44 miles an hour and constantly turns at 72 revolutions per minute regardless of that windspeed. It is rated to produce 100 kilowatts of electricity in a 28 mile an hour wind.

The machine does this by converting the aerodynamic lift on the airfoils to rotational energy at the hub. That energy is then transmitted through the main power shaft. The speed is increased from 72 revolutions per minute to 1,800 revolutions per minute by this speed increaser, which is really just an off-the-shelf transmission. That power is then fed into an induction generator, which is an electric motor being operated backwards. The generator produces

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480-volt alternating current electricity or power at 60 hertz and feeds it down an electrical cable to a cabinet at the base of the tower. It is then fed into the site distribution and collection system. Then, the power goes into a U.S. Windpower-owned substation where it is conditioned and stepped up to be fed directly into the utility grid.

U.S. Windpower's machines utilize a control system which makes use of an onboard microprocessor, which each machine has, which is a little bit hard to see here. The microprocessor monitors all functions of the windmill and feeds this information back to the central control room. It indicates whether the machine is on, how much power it is producing, and what pitch angle the blades are at. The computer also performs various diagnostic functions. This allows the operation of an entire wind plant, hundreds or even thousands of these windmills, from a single desk or a single location in the control room.

We think this control aspect of our wind plant is very important because it makes controlling wind plants very similar—precisely the same, in fact—as the control aspects of a major, central station powerplant. The only difference, of course, would be our site layout and the physical plant itself. We construct miles of roadways, as you can see thousands of towers, foundations, a site collection and distribution system, our own substation, and, of course, the control room.

U.S. Windpower engineers, manufactures, and constructs, operates, and maintains all of this equipment. We feel it is this vertical integration, from soup to nuts, of everything that we do which keeps us in control of it all and helps us to develop it so rapidly. It also, I think, is what sets us apart in this industry of wind generation and makes us one of the leaders.

Finally, I would like to talk briefly about the economic and environmental advantages to generating power from the wind. This chart is put together by the California Energy Commission. What this is is an attempt by the commission to project the cost of future new generating capacity for the State of California.

As you can see, this chart is graduated in terms of cents per kilowatthour delivered. To give you an indication of what this means, typically in New England we are paying in the neighborhood of 10 cents per kilowatthour delivered to our homes. As you can see by the width of the bars for several of the technologies that are under consideration for future new generating capacity, the future market for electrical generating capacity is marked by uncertainty. Predicting future prices becomes more difficult when there are long construction leadtimes, spiraling construction costs, and uncertain fuel prices. Those are particularly volatile because we can't control them.

On the other hand, a wind-power generating plant such as we build can be put on line in a matter of months instead of years. The leadtime is very predictable. The construction costs are also easy to predict. Of course, like other renewable energy resources, we don't use any fuel so we are not subject to the uncertainties of fuel prices. This makes wind power an attractive option for utilities in planning for their future load demand.

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Another important aspect of the wind powerplant is the modular design. Modular construction of the wind plant means that as soon as you put your substation into position, each windmill that you add to the plant can begin generating electricity immediately. Therefore, you can start to get some of the benefits of your construction project long before it is finished. This is quite different from most of the central station powerplants that we're familiar with.

In addition, the modular construction means that if you have regular maintenance that has to be performed, or if you have to effect a repair, you only need to shut down a small portion of your generating capacity in order to complete it, and you can continue to receive power from the rest of the plant. This is another reason for our high availability numbers.

Mr. MARKEY. The gentleman's time has expired.

Mr. FORTIN. Thank you.

[Testimony resumes on p. 120.]

[The prepared statement and attachments of Mr. Fortin follow:]

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WINDPOWER: A CLEAN, EFFICIENT SOURCE OF RENEWABLE ENERGY

by, Mark Fortin & William Aitkenhead
U.S. Windpower, Inc.
October 21, 1985

1) U.S. WINDPOWER, INC. - THE COMPANY

* U.S. Windpower was organized in 1974 by Massachusetts businessmen with experience in starting technology based companies.

* Massachusetts, with its fine technical Colleges and Universities, and the surrounding engineering and high technology firms, provided a fertile environment for research and development efforts of this type. There is an abundance of technical and professional talent to draw upon.

* The local, industrial network of foundries, machine shops, fastener and electrical component distributors, and technical consultants provided an easily accessible support system for prototype development and production.

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* U.S. Windpower grew from a small R & D company to a fully integrated organization with over 420 direct employees in Burlington, Massachusetts; Needham, Massachusetts; Livermore, California; and San Francisco; California. The company employs engineers, technicians, assemblers, mechanics, and machinists, as well as construction, finance, planning and management personnel.

* The company has installed over 1620 wind turbines to date, and has amassed over four million cumulative operating hours on those machines. Our machines have generated more than 235 million kilowatt hours of electricity. Our installed capacity is in excess of 131 megawatts and we have long term power purchase contracts with California utilities to develop 600 megawatts.

* U.S. Windpower has been the single largest producer of wind generated electricity in the industry for each of the last four years.

* California has 95% of the wind generated capacity in the United States. This fact can be attributed to strong seasonal winds, abundant developable land and especially to the cooperative relationship among the California utilities, government, and alternate energy developers. We applaud Governor Dukakis, Congressman Markey, and the Massachusetts utilities, for sponsoring this forum, and for their initiative in helping to make Massachusetts a leader in the area of energy efficiency, technology and conservation. We are proud of our state and happy to be a part of these proceedings.

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2) COMMERCIAL POWER PLANTS - THE PRODUCT

* The U.S.W. Model 56-100 Windmill (see Figures 3A and 3B Machine Layout and Figure 4, Machine Specifications) is a 3 bladed, downwind, variable pitch design with a 56 foot diameter rotor. The machine is free in yaw and operates at 72 rpm. The turbine, (as shown in Figure 3) is engineered and manufactured in Burlington, Mass. The three twenty-eight foot long blades are laminated fiberglass and are manufactured by a U.S. Windpower subsidiary in Warren, Rhode Island.

The machine operates in winds between 12 and 44 mph by converting the lift on the airfoils into rotational energy transmitted to the hub. The main shaft power is delivered to the induction generator after passing through a shaft mounted speed increaser. The generator, rated at 117 KW, operates at 1800 rpm and feeds 480 VAC power at 60 Hz down the pendant cables to the downtower electrical cabinet. The variable blade pitch is controlled by an on-board micro-processor that measures rotor RPM and pitch angle every 100 milli-seconds, analyzes these inputs and adjusts pitch angle as required to regulate power. In addition, the turbine computer continuously monitors machine energy production, running time, and equipment sensors and communicates this information to the site control room.

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* U.S. Windpower's commercial power plants, WINDPLANTstm, utilize a communication and control system developed by our engineers that permits monitoring, control, and diagnosis of hundreds or thousands of windmills from a single location. This control room, makes the monitoring and control aspects of our commerical windpower plant equivalent to most conventional utility power plants.

* The WINDPLANT Physical Plant includes; site roads, power distribution and collection systems, substations, towers, foundations, and control rooms. U.S. Windpower manages the design, construction, operation, and maintenance of these facilities.

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3) THE CASE FOR WIND GENERATED POWER - (Economy, Environment, Jobs)

3.1 ECONOMICS AND UTILITY REQUIREMENTS

* The future market for electric generating capacity is dominated by uncertainty. Electricity demand growth is difficult to predict, new plant costs and lead times can be highly variable and plants with shorter construction cycles and more predictable costs and schedules are desirable. Windmills can be constructed and placed in service in a fraction of the time required for the construction of large central station power plants.

* Modular construction allows a portion of the power plant to begin producing power even while the remainder of the plant is under construction. Portions of the plant can undergo maintenance or repair without interrupting the production of most of the power plant. Windplant construction offers a "pay as you go", or as you need method of adding capacity, as power plant size can be tailored to meet uncertain future load demand.

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* The economics of power produced from the wind are predictable and not subject to the uncertainties of future fuel prices or spiraling long term construction costs. Windpower is a proven technology which can produce highly reliable, inexpensive energy to significantly augment base load sources in a diversified utility grid. U.S. Windpower's fleet of 56-100 windmills has maintained an availability in excess of 95% in each of the last two years.

* Power generated by the wind is less likely to be interrupted or jeopardized by events such as a system failure might cause at a single central station. Fuel shortages or price escalation cannot affect the viability of the plant.

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3.2 ENVIRONMENTAL ADVANTAGES

* Windmills produce no harmful by-products and there are no wastes to dispose of. No fuel is used to produce the power and therefore none has to be extracted, refined, transported, or stored.

* Windpower plants have predictable decommissioning costs and disposal processes. After a windfarm has completed its useful generating life, the plant can be inexpensively regenerated or returned to an environmentally benign original state.

* Typically, when power is generated from the wind, a utility will adjust the mix in its grid to reduce fuel consumption in part of its baseload generating equipment (usually oil or coal fired plants). Wind energy in the United States has saved the equivalent of 980,000 barrels of oil through September, 1985. The burning of that much oil would have produced approximately 5,880,000 pounds of atmospheric pollutants.

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3.3 JOBS

* U.S. Windpower currently has over 420 direct employees engaged in Engineering, Production, Maintenance, Construction, Finance, Planning, Operations, and Meteorology. The windmill industry, as it grows, will create thousands of new jobs in many fields.

* Our windmills are made up of many manufactured components purchased from firms in New England and around the Country. We utilize electric motors, solid state components, high strength fasteners, gear boxes, disc brakes, electrical switch gear, bearings, printed circuit boards, shaft couplings, and many other industrial components. Our account represents a significant portion of the business of a number of suppliers and creates hundreds of indirect jobs.

* We use a significant number of specially designed components which are machined for USW from stock materials or USW designed steel or aluminum castings. Foundries and machine shops in New England and the Midwest work hard to supply our production line with finished goods. We currently assemble 24 wind turbines a week.

* In the years to come, there will be a growing demand for wind generated electricity in the United States, and around the world. The size and strength of the domestic windmill manufacturing community will dictate whether a significant portion of the needed machines are produced here, or by any of the many foreign manufacturers aggressively pursuing the American Wind Turbine market. Windpower generation is going to be big business. It can be a tremendous source of new employment and economic opportunity.

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U.S. WINDPOWER, INC.
Facts

COMPANY

- Produced 50% of the wind generated electricity purchased by the Pacific Gas and Electric Company in 1984 and 1985
- Produced 37% of all wind-generated electricity in California to date
- Operates and services 131 MW of Windplants℠ in Northern California
- Raised approximately $190 million in private capital for wind energy development, including $20 million for research, engineering development and internal expansion
- Organized in 1979 by Stanley Charren and Russell Wolfe, businessmen with experience in starting technology-based companies
- Employs 420 engineers, draftsmen, mechanics, construction, finance and planning personnel in 3 locations - Burlington (MA), Livermore (CA), and San Francisco
- Holds power purchase contracts to develop an additional 450 MW with California's two largest utilities

PRODUCT

Commercial Power Plant
Power Collection system ties hundreds of windmills to central substation
Communication system connects all of windmills to central computer
- Permits monitoring, control and diagnosis of its 1300+ windmills from a single location
- Provides an extensive data base on all major subassemblies
- Promotes rapid design evolution and efficient maintenance

Model 56-100 Windmill
- 56 foot swept diameter
- Produces 100 kW in 29 mph wind
- 210,000 kWh average annual production (Altamont sites)

OPERATIONS

	1981	1982	1983	1984	1985**
Machines Installed	32	407	834	1,336	1,620+
MW Installed	1.6 MW	20 MW	46 MW	96 MW	131 MW
Operating Hours	1,000 hrs	104,000 hrs	691,000 hrs	1,838,000 hrs	4.0+ mil hrs
Energy Generated	10,000 kWh	3.5 mil kWh	25.5 mil kWh	87.5 mil kWh	235+ mil kWh
BBL Equivalent (1 barrel of oil = 600 kWh)	16	5,833	42,500	145,833	391,666
Home Equivalent (Average PG & E residential customer uses 6,000 kWh annually	1	583	4,250	14,583	39,166

Note: Numbers in chart are cumulative

** Through September 1, 1985

Figure 1

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WIND INDUSTRY IN CALIFORNIA

	Industry Total	U.S. Windpower Total
Machines Installed	9796	1620
MW Installed	643 MW	131 MW
Energy Produced	688 Million KWH	235 Million KWH
Operating Hours		4.0 Million Hours

California has 95% of the wind-generated capacity in the United States.

U.S. Windpower has been the single largest producer of wind power in each of the last 4 years.

Figures show cumulative growth in 4 years and reflect the status of development as of September 1, 1985.

Source: California Energy Commission, Wind Industry Trends, December 1984.

1985 data from Southern California Edison Company and Pacific Gas and Electric Company

Figure 2

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WIND TURBINE GENERATOR

- 56 Foot Swept Diameter
- 100 KW Power Rating

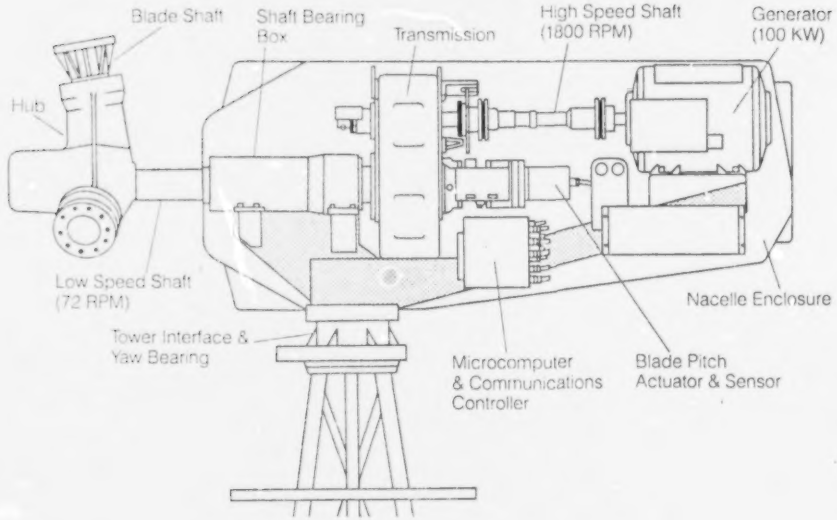

Figura 3A

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WIND TURBINE INSTALLATION

Figure 3B

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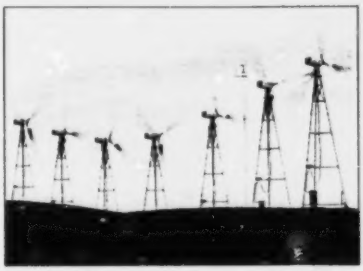
U.S. WINDPOWER, INC.
Model 56-100 Specifications

ROTOR	
Type	Variable pitch
Number of Blades	3
Diameter	56 ft. *(17 m)*
Rotational Speed	72 rpm
Rotational Direction	Clockwise
Orientation	Downwind, free yaw
Hub Height	60 ft.
BLADE	
Length	26 ft.
Tip Speed	144 ft./sec.
Swept Area	2,463 sq. ft.
Material	Fiberglass composite
TOWER	
Type	Tripod
Base Area	242 sq. ft.
Material	Heavy gauge galvanized steel pipe
TRANSMISSION	
Type	Shaft-mounted, helical gear increaser
Input Speed	72 rpm
Output Speed	1,800 rpm
Ratio	1:25
GENERATOR	
Type	Induction
Rating	100 kW
Voltage	480 VAC
Speed	1,800 rpm
Frequency	60 Hz
CONTROL SYSTEM	
Blade Pitch Control	Electro-mechanical
Overspeed Control	Blade pitch feathered
PERFORMANCE	
Cut-in	12 mph *(5 m/sec.)*
Rated	100 kW at 29 mph *(13 m/sec.)*
Cut-out	44 mph *(20 m/sec.)*
Survival Wind Speed	125 mph *(56 m/sec.)*
WEIGHT	
Turbine	6,500 lbs.
Tower	6,000 lbs.



U.S. Windpower's Model 56-100 turbine offers proven productivity and reliability. In their first full year of operation, the first 99 56-100s produced an average of 220,000 kWh each with over 300,000 cumulative operating hours and 95% availability.

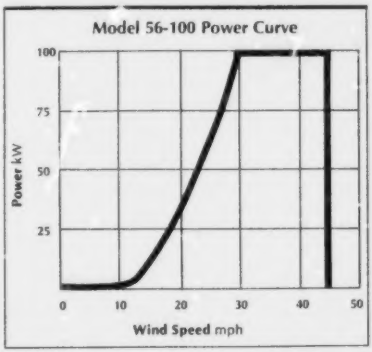


Figure 4

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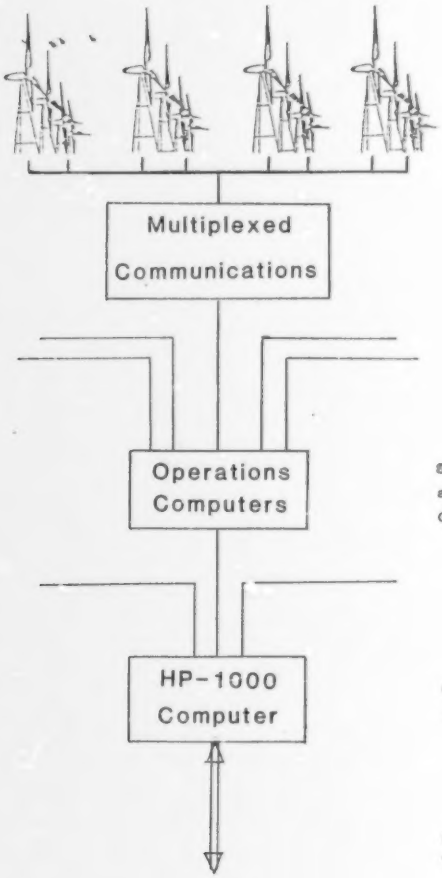
WINDMILL COMMUNICATION AND CONTROL SYSTEM



U.S. WINDNET

Figure 5

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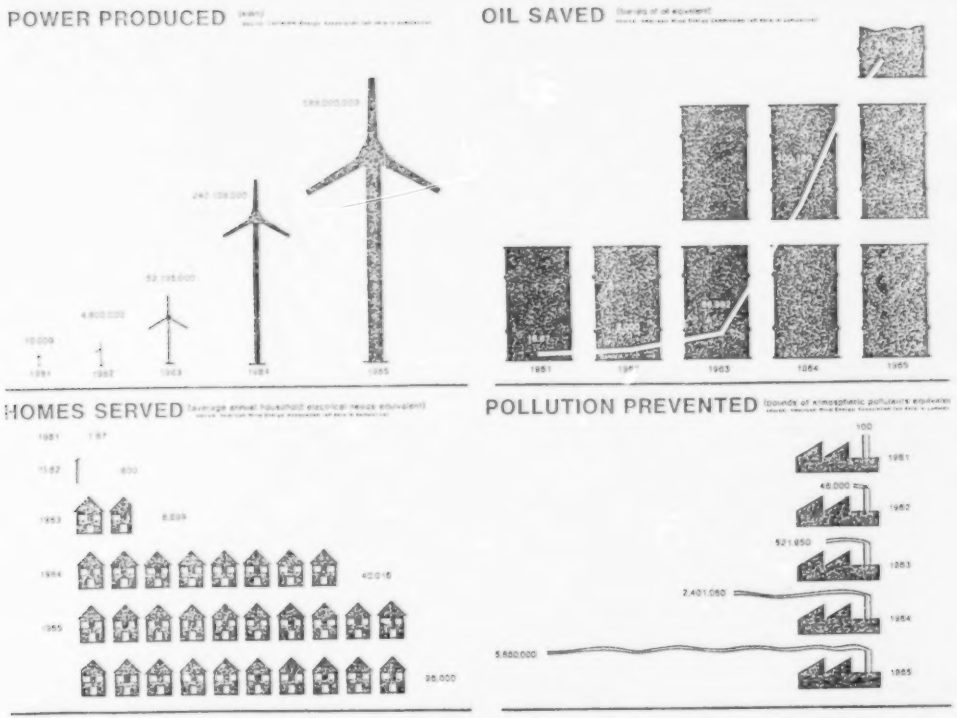

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SOURCES OF INFORMATION

1. The American Wind Energy Association
2. The California Energy Commission
3. Pacific Gas And Electric Company
4. Southern California Edison

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Mr. MARKEY. Thank you.

Our next witness is Mr. J.J. Briody, who is senior vice president for the North American Philips Lighting Corp.

STATEMENT OF J.J. BRIODY

Mr. BRIODY. Thank you, Mr. Chairman, and members of the committee.

My main message today is that good quality lighting need not be sacrificed to accomplish significant energy conservation. Electric lighting consumes only 4 percent of the world's primary energy, but it offers, however, immediate opportunities to save hundreds of millions of barrels of oil through the use of state-of-the-art lighting products, some of which are displayed up here today.

The key is the right light source combined with the optimum fixture to deliver quality light to the seeing task area. A major impediment to getting the right lamp and system used is the poor understanding of lignt cycle costs and the unwillingness of consumers and business managers to commit today's revenue flow to tomorrow's savings and paybacks. Let me give you an example here, if I can.

The only way to really visualize this is to give you a contrast of wattage, which most of us understand. Utilities sell kilowatts, megawatts, and zoomawatts, whatever the next level of declension is. We deal in our lives with watts. Everythng we use is watts.

Let me give you a comparison. This is a 60-watt light bulb. Most of us use those in our homes. This is a 55-watt low-pressure sodium light source. Now, the first reaction is I prefer the white because that's the way I've grown up. That's the environment which I lived in, and we all prefer the white. But you're comparing 60 watts of energy versus 55 watts of energy. You're comparing 20 lumens per watt to 180 lumens per watt.

Now, what is the choice? The choice is determined by what your need is from a color-rendering point of view. Certainly you will not use low-pressure sodium in your home, for obvious reasons. But you can use low-pressure sodium in your streets, illustrated by the fact that Long Beach, CA, San Jose, and most recently the city of San Diego, after several years of deliberation, decided to convert their street lighting from mercury lighting, which we are most accustomed to—that's that blue-white light—to the low-pressure sodium source. The savings for those three cities combined over the next 10 years exceeds $140 million. Those are taxpayers' dollars. Two of those projects were aggressively supported by the U.S. Government to subisize the investment in the capital equipment.

Now let me go back to the 60-watt light bulb again. We use this in our homes. There are billions of those light bulbs purchased every year in our hardware and our grocery stores and our electrical wholesalers. This lamp over here is a 7-watt. This is a 7-watt and that's a 60-watt. The 7-watt lamp, readily available from a number of different manufacturers, can more than replace that light bulb in the home. The problem is that this light bulb costs $1 to you and I. We're accustomed to spending that dollar. To buy a system like this, or a system like this lamp here, will cost somewhere in the area of $15 to $20. It boggles our imagination to think

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about paying 15 or 20 times for a new product what we're accustomed to paying for an old product.

I mentioned life cycle costs. The impediment in our Nation to the conversion to more efficient, energy-saving lighting products, no matter who they come from, by the way, is to understand life cycle costs. The use of this product or this product versus this product saves $60 over the life of the product. The payback is roughly 3½ months. The message has not penetrated. We don't understand that message and, therefore, we are boggled by the thought of paying up front a very heavy amount of money in order to earn back over months and years the energy savings that justifies that investment.

Businessmen, like people in this room, can make those decisions every day. They are very easy. They are capital investments and they are measured on return on investment. But the average householder can't make that kind of a decision.

As I said, replacing a dollar light bulb with a $15 system boggles the mind of the average consumer and flies in the face of business management's mentality, which struggles every day to make this quarter or to make this year. Massachusetts has been a leader among the States in adopting state-of-the-art lighting systems. I'm just going to mention three to you because, I think, they stand out.

One is the Massachusetts Turnpike, where there has been 2.3 million kilowatthours saved, or a quarter of a million dollars, Cape Cod Canal, 600,000 kilowatt-hours, and the University of Massachusetts, 1.4 million kilowatt-hours. That totals up to over $1 million in energy savings per year just in three examples.

Thank you very much, Mr. Chairman.

[Testimony resumes on p. 140.]

[The prepared statement of Mr. Briody follows:]

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Written Statement

J.J. Briody
Sr. Vice President,
Industrial/Commercial Division
North American Philips Lighting Corporation

GOOD LIGHTING - AN UNDENIABLE RIGHT OF MANKIND

Characteristically, man tends to take the results of his own technical achievements for granted. This particularly applies to one of the most beneficial technologies developed in the last hundred years: electric lighting.

If the world were suddenly deprived of the benefits it brings, modern society would be disrupted. Without lighting, nighttime traffic would grind to a halt, the role of commerce and industry in the national economy would be severely curtailed, crime rates would soar, domestic life would be reduced to its former primitive level and leisure would no longer provide the pleasure it offers today.

Electric light, in fact, has become instrumental in creating optimum working and environmental conditions. It has made our lives safer, more comfortable, more secure. In a word, human well-being has become largely dependent on it. Good lighting has developed into a fact of life, an undeniable right of mankind.

Can this right still be claimed at a time when it is imperative to save energy and cost? The answer is an unreserved "YES"!

Proper management of the factors governing high quality lighting design allow excellent lighting while saving both energy and cost.

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DOING BETTER - NOT MAKING DO WITH LESS

Lighting is a modest consumer of energy, accounting for only a small fraction of primary energy usage worldwide.

The power needed to operate a 1000W vacuum cleaner for one hour will keep a standard 60W household incandescent lamp burning for 16 hours and a 18W SL* Lamp - which gives as much light as the 60W incandescent - for approximately 55 hours!

Nevertheless, many people believe that lighting is the most notorious "energy guzzler" under the sun, because it is an area where energy is seen to be used. Unfortunately, this misconception is often fed by incorrect energy advice given by well-meaning authorities. The myths that have arisen may have serious consequences. They tend to erode lighting standards which are vital to our social and economic welfare. In some cases they even led to indispensable lights being turned off.

Of course, in the field of lighting, there are opportunities to conserve energy, since lighting has an enormous power-saving potential. And to tap this potential it is not necessary to live in darkness or semi-twilight!

Few industries have improved the energy-effectiveness of their products so dramatically over the last thirty years as the lighting industry. For example, since 1950, light source manufacturers have succeeded in stepping up the efficiency of mercury-vapor lamps by 65%, of fluorescent lamps by 80% and of low-pressure sodium lamps by 115%. In additions, quite a number of

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spectacular new energy-effective lighting products have been developed in the last decade. As a result, it is now possible to reduce energy consumption without detracting from the great benefits of good lighting.

SAVING ENERGY SYNONYMOUS WITH SAVING MONEY

Escalating energy costs have shifted the emphasis away from initial capital investment towards operating costs, with energy consumption as the major component. Consequently, curbing power consumption can also pay rich dividends from a financial point of view.

This consideration should be taken into account when designing new lighting systems or reviewing existing installations. Many of the latter are far from energy and cost-effective. Often, they can easily be converted to provide the same or better lighting at a lower energy consumption and cost, simply by switching over to more efficient lighting equipment. Analysis of existing installations indicates that the potential saving in power usage achieved by conversion averages about 30% for the same or higher lighting standards. In many cases little or no capital expenditure at all will be involved. In others, some capital outlay will be required, but the pay-back periods are usually relatively short.

In the last decade the progress made by the lighting industry has been impressive. So impressive, in fact, that if a lighting installation is ten years old, it would be wise to question its energy and cost-effectiveness.

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And the design of new installations should be based on a full knowledge of the latest developments in lighting. Otherwise they may be obsolete before they come into operation.

FROM VISUAL REQUIREMENTS TO LIGHTING REQUIREMENTS

When "translating" visual requirements into lighting requirements, four quantity and quality criteria stand out: Here's a brief look at each of these criteria:

- The amount of lighting
- The balance of lighting
- Glare
- Color rendering

THE AMOUNT OF LIGHTING - LIGHTING LEVELS

The human eye - that ingenious sense organ - is one of man's most precious "possessions". Without it, light would have no meaning.

The visual tasks to be performed by our eyes are almost as widely divergent as the activities pursued by man. They may be related to productivity, safety or recreation, to the display and sale of merchandise or to the creation of an appropriate atmosphere. In all instances, the quantity of the lighting - measured in footcandles - should be purpose-oriented. The smaller the detail or the lower the contrast, the more light our eyes need to do their difficult

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job. Insufficient lighting will have a negative influence on human well-being resulting in uneconomic and inefficient operation of the building, roads, etc., for which it is used.

Decades of international scientific research have gone into the study of lighting levels for specific visual tasks.

Footcandles	Area of activity/applications
10	Circulation areas (e.g. corridors)
30	Foundry bays, saw mills
50	Class rooms, lecture theaters, libraries
75	Laboratories, general offices, typing pools, computer rooms, conference rooms, self service shops
100	Fine work e.g. electronic and office machinery assembly, proof reading, drafting offices, vehicle body assembly, local medical inspection in examination rooms (hospitals), retouching, etching, precision proofing

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Footcandles	Area of activity/applications (con't)
200	Steel and copper engraving
500	Final difficult body assembly
3000	Local lighting in operating theaters

Lighting levels under the sun and the moon

Summer, under a cloudless sky, in the open	10000 fc
Ditto, but in the shade of a tree	1000 fc
In the open, under a heavily-overcast sky	500 fc
Indoors by the window, shady side on a fine day	200 fc
Full moon, in the open, on a clear night	2.5 fc

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AGE AND QUANTITY OF LIGHT

There is a clear relationship between age and the amount of light that is required for a particular eye-task. As seen in the table below, a person of 60 may need as much as 15 times more light than a child of 10 under the same circumstances.

Relative illuminance needed by different age groups to carry out a specific eye-task:

At 10 years of age 1
At 20 years of age 1.5
At 30 years of age 2
At 40 years of age 3
At 50 years of age 6
At 60 years of age 15

LOWERING LIGHTING LEVELS IN INDUSTRY - A COUNTER-PRODUCTIVE MEASURE

Particularly in industry, the quantity of lighting is also a quality concern. If an installation does not provide enough light for the tasks to be performed its quality can be inferior.

Lowering lighting levels to sub-standard values in order to control energy consumption and cost may be a counter-productive measure in the truest sense

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of the word. More than thirty years of research have shown unquestionably that the financial losses resulting from inadequate lighting may be enormous from decreased productivity. It has also proved that proper lighting in industry goes a long way towards reducing fatigue, rejects and accidents.

THE BALANCE OF LIGHTING

Proper light distribution is very important for both visual performance and visual comfort. Too much contrast will produce a restless effect, sometimes having unproductive results with respect to visual performance. On the other hand, too "flat", shadowless lighting will appear dull and will not provide a good three-dimensional impression of either people or objects. Moreover, it lacks the power to draw attention. A sensible balance is necessary, avoiding both over-diffuse and too strongly directional light.

GLARE

Glare - both direct or reflected - usually results in discomfort or, in extreme cases it can lead to disability in seeing (dazzling car headlights). Glare discomfort is generally experienced by people exposed to a minor amount of glare for a prolonged period of time. It is often accompanied by complaints of fatigue or headache, without the victim realizing the cause. It could, for example, result from a lighting installation consisting of unshielded light sources in decorative luminaires.

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COLOR RENDERING

Colors of objects are partly determined by the light under which they are viewed. The way in which the light "reproduces" these colors is referred to as color rendering. Some lamps produce light which is remarkably similar to sunlight and whose color rendering is viewed as "true-to-life". Others provide light which makes it difficult to distinguish one color from another. This must be considered when selecting a light source, as the color rendering requirements vary from application to application. There are cases in which it is important to see colors in electric light in the same way as in daylight. Think, for example, of certain applications in hospitals, for high quality printing and some art galleries. In industry, it is often enough to be able to discriminate between colors. Offices generally require good color rendering, not only for the visual tasks involved, but also in creating a pleasant working atmosphere. This is extremely important in places where we meet to enjoy ourselves, such as restaurants. However, in the case of road lighting and security lighting, there is rarely any need for a high degree of color discrimination

MEETING LIGHTING REQUIREMENTS IN AN ENERGY/COST-EFFECTIVE WAY

When it comes to creating low-cost, high quality lighting is is imperative to

choose the right light
which should be directed to where it is needed
and used only when it is needed

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THE RIGHT LIGHT

Just as cars are designed for different purposes, so are lamps. And, consequently, just as cars have different efficiency ratings - expressed in miles per gallon - so do lamps. The efficiency - or, in lighting engineering terms, the efficacy - of a light source is indicated by the unit lumens per watt (lm/W). It is a measure of the relation between the amount of light produced and the amount of power consumed. The efficacy of different light sources varies dramatically: from less than 10 lumens per watt to over 200. There are so many different light sources available today that you should be able to choose the right energy-efficient lamps for a given application. Here are comparative maximum efficiencies in lumens per watt of different lamp types:

. Incandescent	24
. Fluorescent	100
. Mercury Vapor	63
. Metal Halide	125
. High Pressure Sodium	140
. Low Pressure Sodium	200

When evaluating a lamp for an installation, this is a factor that should be a focal point. Energy consumption is almost always the largest single item in the total cost of lighting. A simple example:

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The cost of the energy consumed by a 100W incandescent lamp during its life is 10 times the original cost of the lamp*.

Everything possible should therefore be done to control the energy component of the total cost structure. The fact that costs have risen sharply in the last few years - and are bound to continue climbing in the future - is just one more compelling reason for choosing the most efficient and most suitable lamp for the application concerned.

THE RIGHT LIGHT WHERE IT IS NEEDED

One of the most important functions of a luminaire is to insure the efficient distribution of the light. For example, if a bare, unshielded fluorescent lamp is used in a strip fixture, the light is emitted in almost all directions, including those where it is not needed. Obviously, much more light will reach the working plane beneath the lamp if suitable optics are fitted in the form of a simple reflector or a more sophisticated lens or louver system. The use of these optics may lead to a saving in energy of as much as 35%. So here, too, there are many opportunities to reduce costs.

*In view of the fact that kilowatt hour cost and lamp prices are not the same everywhere, the ratio may differ somewhat from area to area.

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THE RIGHT LIGHT WHEN IT IS NEEDED

Unnecessary light is wasted light. It means energy squandered, money thrown away. Modern dimming and switching systems minimize this wastage. They enable the lighting to be adjusted to needs which change with the availability of daylight, the kind of work on hand and the presence of people.

GETTING THE MAXIMUM OUT OF EVERY WATT BY PLANNED MAINTENANCE

Dirt and dust on lighting equipment absorb light and therefore waste the energy it takes to produce it. Few people know that this absorption may amount to as much as 50%. Then there is the inescapable fact that the longer a lamp burns, the less light it delivers. For example, after 7500 burning hours the light output of a fluorescent lamp has lost 20% of its original value.

Obviously, lighting equipment which has become dirty and lamps whose light output has depreciated are sources of wasted energy costs. For although their performance has decreased substantially, their energy consumption has not! Apart from this, the amount of light provided by the installation concerned will gradually drop to a level which no longer meets the minimum requirements. There are two ways to tackle this problem. The first is to install an extra quantity of light so that the appropriate lighting level is insured at all times - even when soiling and lamp life are in an advanced stage. The second, and far more cost-effective solution is PLANNED

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MAINTENANCE. This means the replacement at regular, pre-calculated intervals of all the lamps (and, where applicable and necessary, any auxiliary equipment too). This method provides for group relamping at a point where it is more economical to replace present lamps than to continue their (inefficient) operation. The luminaires should be cleaned simultaneously.

Finally, group relamping offers yet another distinct advantage. It avoids a situation in which the maintenance men have to go up and down the ladder each time a single lamp has given up the ghost. This is an expensive operation by any standards, as it involves extremely high labor costs and, in many cases, serious disruptions of the production process.

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LISTING THE INDIVIDUAL COST ELEMENTS

In order to make a sound, financial analysis of a lighting installation it is, of course, necessary to include all the relevant cost elements. These are:

1. Capital cost of lighting equipment
2. Cost of installation (labor and additional materials)
3. Cost of replacement lamps
4. Cost of maintenance, cleaning and lamp changing (labor)
5. Cost of electrical energy

It is an established fact that energy waste due to inefficient lighting is gigantic. Today, the low-efficiency incandescent lamp still accounts for 45% of all the electricity consumed worldwide for lighting. Yet, its share in the total amount of light produced by all lamps throughout the globe is a mere 20%. Many of these incandescent lamps could very well be replaced by far more energy-effective light sources.

Likewise, a large number of the mercury-vapor lighting installations currently in use qualify for conversion to high-pressure or low-pressure sodium lamps.

If all the existing lighting schemes which use the "wrong" type of lamp "for the job" were to be refitted with an appropriate, more efficient light source, the resultant savings is energy AND overall cost would be colossal! In fact,

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the total of the world's primary energy which is consumed by lighting could be reduced by up to 40% if modern lighting were installed. And, what is more, this reduction could be achieved while adhering strictly to top-quality lighting criteria.

SO, WHEN IT COMES TO MAKING YOUR CHOICE OF LAMPS, IT WILL PAY TO INVESTIGATE BEFORE YOU INVEST!

With their output of up to 130 and more than 200 lumens per watt respectively, Philips high pressure and low pressure sodium lamps top the list of the world's most efficient light sources. The following will illustrate their efficiency:

To reach the same lighting level, we can light - using the same amount of energy - 37 miles of road with mercury vapor lamps, 74 miles with high pressure sodium lamps and a full 188 miles with low pressure sodium lamps. Small wonder that these lamps are so widely used in all corners of the globe to obtain low-cost, top-quality lighting.

MASSACHUSETTS ENERGY SAVING EXAMPLES

Here are practical examples of low pressure sodium installations: the Massachusetts Turnpike Authority replaced 400W mercury vapor lamps on the median of the Weston-to-Boston Extension, the on and off ramps in the City of Boston and the acceleration and deceleration lanes at fourteen turnpike, restaurant and service areas from Boston to the New York State border. Philips 90W low pressure sodium lamps and fixtures were the replacement choice. The total installation involved 1625 low pressure sodium lamps

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which saved 321 watts per fixture or a total savings of 2,285,000 kilowatt hours per year and yielded an annual saving in energy costs of over two hundred thousand dollars, with a pay back of 1.39 years. The lamp's monochromatic yellow color improves visibility with better eye adaptation and visual clarity and greater speed of perception of objects, both moving and stationary.

At the Cape Cod Canal there was a need to relight to improve visibility for ship traffic passing through the waterway. The solution was to replace 175W metal halide lamps with 55W low pressure sodium lamps. Visibility was improved sixty nine percent. An additional benefit was the resulting savings in energy of approximately 567,000 KWH and $5,700 annually. Both Canal bridges are contemplating a lamp replacement program - from 150W high pressure sodium to 55W low pressure sodium for design compatibility as well as further energy savings.

The Town of Merrimac, Massachusetts when faced with "Proposition 2-1/2" initially turned out all of its street lighting. The solution to complying with the State energy restrictions and yet providing for the outdoor lighting needs of the citizens was to replace the 400W mercury vapor lighting system with 55W SOX lamps. Now the entire town is lighted with low pressure sodium, which has resulted in compliance with the mandate of the proposition and afforded the town a safe and efficient street lighting system.

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PHILIPS PL* LAMPS

Philips' new low-energy and therefore highly cost-effective PL* lamps are another recent asset to modern lighting technology. They are available in 5W, 7W, 9W and 13W versions whose light output can be compared with that of 25W, 40W, 60W and 75W incandescent lamps. Their compact size, energy efficiency and long life of at least 10,000 hours make these lamps ideal for a wide variety of applications. Just one case in point:

MASSACHUSETTS ENERGY SAVING EXAMPLES

The University of Massachusetts, at Amherst, has recently begun a program of replacing incandescent lamps with PL* 7W, 9W and 13W lamps in downlight fixtures throughout the campus. Over two thousand PL* Lamps have presently been delivered out of the anticipated eleven thousand socket conversion, when completed this installation will save approximately 1,400,000 KWH and $14,000 in annual lighting costs.

In progress too, is a Boston Edison marketing program to introduce the PL* Lamp to both residential and commercial customers. The objective is to reduce energy demands to within the generating capability of present facilities.

THE LAST WORD

Good lighting is not only a matter of expelling darkness but it has become a fact of human life. It reduces nighttime traffic accidents by 30 to 45% and is a deterrent to crime. It increases productivity and has a positive effect

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on the well-being of the people involved in the production process. It gives us access to museums, libraries, hospitals and sights of historic interest and community pride. It turns houses into homes, where it promotes comfort and peace of mind - of growing importance in this highly stressful world of ours. It provides the means to enjoy nighttime recreation. Sports, are a a favorite pastime for millions of people, everywhere, and lighting makes it possible to televise the world's most important events. It enables shipping and aviation to carry on when sun sets. In short, it is lighting that makes us independent of natural light and keeps the world alive after dark...

Even today, more than a century after the advent of the first incandescent lamp, there are many areas throughout the globe which are still heavily "underlighted". That is one reason why the last word on lighting has not yet been said.

Better lighting will continue to be one of man's most important basic needs, even at a time when energy and cost-consciousness is in prime focus. However, it will take professional expertise to attain this objective since energy-oriented lighting designed requires more than a superficial knowledge of lighting engineering fundamentals. In addition, today's range of lighting equipment is so sophisticated that the non-initiated run the risk of making inaccurate decisions.

Philips Lighting designers and application engineers are trained to discover the exact combination of lighting factors to meet customers' needs. Everyone depends on artificial light sources night and day, every day. As the worldwide leader in lighting, we never take this dependence for granted. Our business is lighting. Combining American and European technology, North American Philips Lighting is now in the best position to provide high quality products to satisfy your ever changing lighting needs.

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Mr. MARKEY. Thank you. The gentleman's time has expired. Now we will move into the question and answer period of this panel.

What I would like to do, if possible, is perhaps ask the people behind you to move up to the table with their chairs and to pass the microphones around as the different participants have something which they might want to contribute.

I would like to begin by asking this question in general and then open it up for anybody who might want to, in fact, comment upon the area that is raised. That is, what Federal legislative initiatives, including the revision of the Tax Code or energy policy, could best assist the alternative energy industry to continue to grow and participate in the changing energy mix in this country.

Mr. FORTIN. From our standpoint—this is U.S. Windpower—since the extension of the existing tax credits unfortunately appears unlikely, I think the thing that would help us the most, as you mentioned earlier, would be the removal of all subsidies from all energy sources. We would like to get an opportunity to compete directly with all of the other sources of energy, especially the more conventional sources.

Mr. MARKEY. Any others? Mr. Little.

Mr. LITTLE. Certainly the extension of the tax credit for renewable energy is important. Also——

Mr. MARKEY. What would the elimination of the tax credit mean?

Mr. LITTLE. I think it would have a very serious effect upon the renewable energy industry in the United States. I think it would be devastating unless, of course, there was this level-playing-field concept.

Mr. MARKEY. Devastating.

Mr. LITTLE. Yes.

Mr. MARKEY. What do you mean by devastating?

Mr. LITTLE. Well, I think the U.S.-based renewable energy industry would not be able to survive the short term, the next 2 to 3 years, until we project the price of oil will be higher and we can be more competitive.

Mr. MARKEY. Mr. Goldner, do you have any view on that?

Mr. GOLDNER. I would like to put in a plea for assisting companies so they can invest more in research and development in these areas, so that they get a better return on their investment. Furthermore, the same thing applies to universities. I think the solar energy area has been virtually wiped out so far as research is concerned, not only in photovoltaics but in many other areas. We have found the Federal Government has removed a lot of its research and development support.

Mr. MARKEY. Mr. Little, you're in this business. What has happened with the solar industry? Has it been literally wiped out, the new research?

Mr. LITTLE. The solar energy budget has been reduced to about 32 percent of what it was in 1981–82. That's had an effect.

Mr. SIKORSKI. If you could adapt it to Star Wars you would have a full budget.

Mr. LITTLE. That's correct.

Mr. MARKEY. My time has expired. Any questions?

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Mr. SIKORSKI. You have the numbers with regards to comparing these resources with the traditional resources—nuclear, how we subsidize nuclear, and how we subsidize coal and oil and the rest of it, the tangible drilling costs, writedowns and all the rest of it.

Are you going to put that into the record?

Mr. FORTIN. Yes. That information exists in the record. It is also available directly from the California Energy Commission. They're going to use it in future permitting processes to make sure the utilities in California look at all the alternatives before deciding to build large central station powerplants.

Mr. SIKORSKI. You used their data for your analysis and where you put your bars. Is that accurate for your experience?

Mr. FORTIN. I can't speak for the costs of other generating capacity. The range that they showed for wind power in the 1990's was from 7.5 to 11 cents a kilowatt-hour. We are already achieving the low end of that spectrum. We are producing power from 7 to 8 cents a kilowatt hour, and our costs are going down rapidly. We're learning the machines are becoming easily maintainable.

Mr. SIKORSKI. This operation is producing for that?

Mr. FORTIN. That's right.

Mr. SIKORSKI. You could put a couple of those on Capitol Hill and you would have——

Mr. FORTIN. We got where we are today by the use of the Federal tax credits, so in our case they certainly are serving their intended purpose. We could move a lot quicker if they were to be extended. We don't want to bet our company on that happening so we have already achieved an economically viable product in the absence of these tax credits.

Mr. SIKORSKI. Your wind power is usable along the coast lines and along the Great Lakes, where there are large areas of wind, but not usable all across the country; is that correct?

Mr. FORTIN. There are certainly some areas of the country that are better than others. California has 95 percent of the installed capacity to date. There are some reasons for that. They have strong seasonal winds which are thermally affected by the central valley rising up and the cooler air from the coast coming in to fill the void, so they really do have the best steadiest wind sites. They also have a very cooperative attitude that exists between the government, utilities, and the developers.

The same could be said for Massachusetts, and I think that is one of the reasons that we're also a leader in the development of energy technology. There are other areas of the country that have very good wind resources. It's a mixture of getting the right price for the energy, having the wind resources, the cooperation of the utilities, accessable land, and available construction and maintenance workforce.

Mr. SIKORSKI. I had one question for Mr. Goldner. Is this smart window a chemical process? You either need to do something to the glass in its production, or you do something to the glass after its production. So the costs of that are still high, until it is researched further, or until it is developed on a mass production basis?

Mr. GOLDNER. Let me try to answer that briefly.

What I showed you were thin films that are put on glass, and that is basically the way it will probably end up. This is no differ-

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ent than films that are presently put on windows, but they're static. Their optical transmission properties cannot be altered after installation.

Mr. SIKORSKI. So it is a chemical process of applying film and then using electricity or an electrical charge to change it to the color desired?

Mr. GOLDNER. That's right. I didn't go into any technical discussion about how electrochomic materials operate. I would just say that inserting electrons and charged compensating ions is the way you perform the change in the optical transmission. It's the fact that you have inserted or extracted electrons that affect the optical properties.

Mr. SIKORSKI. What is the cost of that now?

Mr. GOLDNER. The cost of operation, as I indicated earlier, is minimal. The cost of producing it isn't much greater—would not, in the long run, as I see it, be much greater than what you presently have for tinted windows, what are called low E—low emittance—windows.

Mr. SIKORSKI. You need a little something running this operation in your house. You need a control system that will run the operation.

Mr. GOLDNER. Oh, yes.

Mr. SIKORSKI. In Minnesota in the middle of winter we need something that would keep the cold out on the north side and let the heat in on the south side.

Mr. GOLDNER. Precisely. That is the beautiful part about smart windows. That's why the word "smart" comes in. That is, one can have a thermal sensor, an optical sensor, a humidity sensor, any other sensor one might imagine. With low-cost electronics, you can easily control the optical properties of that window.

Mr. SIKORSKI. You need some smart policymakers in Washington, including the President and Secretary of Energy, to look out the windows.

Mr. GOLDNER. If I might add to that last statement, I would like to say that one of the things that we're trying to do is not only research—and I tried to bring that out in my brief testimony, both written and oral—but education, which I think, is a vital issue in this Nation at the moment. This is an issue that we're trying to handle very much at the moment, not only at Tufts but especially at Tufts through our Electro-Optic Technology Center, through the type of education that we're providing.

Mr. SIKORSKI. I thank you.

I wanted to commend you, Miss Dubester. That community work is absolutely essential to hold on and to move the Nation into a better energy situation. I want to thank you and I thank you all.

Mr. MARKEY. Thank you.

I ask this question in general, and anyone can volunteer on it as well. How much, if any, research and development money for the types of energy products that you're interested in, that your companies develop and now manufacture, how much of that was done by a Federal Government grant or subsidy? Have any of you been benefited by Federal programs? Miss Dubester.

Ms. DUBESTER. Yes, sir.

Mr. MARKEY. You have been. Can you tell us how?

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Ms. DUBESTER. Well, not right now, but in 1979 we did a program where we designed and put low-cost solar space heating systems on low-income homes. We trained people with CETA when that was around. We haven't been doing completely pure research, not at the high technology end of the spectrum, but definitely at the low technology and the appropriate technologies. There is the DOE Small Grants Appropriate Technology Program, which has been abolished, and we definitely benefited from all of those. I think they were extremely cost effective.

I wanted to ask you one question, which is do you think there is any hope for the solar and energy tax credit at this point, or is it just a foregone conclusion that it's going to run out?

Mr. MARKEY. Well, that's very problemmatic. As you know, we're in the wilderness right now with regard to alternative energy resources and conservation with regard to Federal Government policy. As the legislation is now developing, it has been eliminated even from Congressman Rostenkowski's bill in the House, again allowing for this two-tiered—you know, first-class and second-class energy agenda to be established in the country.

Mr. SIKORSKI. Drilling costs is in the President's proposal but the solar energy credit is not.

Mr. MARKEY. I'll give you one interesting statistic that might be of interest to you, which just shows what has happened with the energy agenda of the country since President Reagan took over.

As you know, the Department of Energy also develops nuclear weapons for the United States. That's a little known fact. Even as you see the Department of Defense budget debated every year, very little focus is placed on the fact that the Department of Energy does all the work on nuclear weapons. In 1981, when President Reagan took over, two-thirds of the Department of Energy budget was on energy technologies and one-third was on nuclear weapons. In 1985, two-thirds of the budget is for nuclear weapons and one-third is for energy. I think that fairly well reflects the transition, the transformation that has taken place in this country over the last 5 years in terms of our collective priorities and, unfortunately, it reflects very poorly upon the likelihood that we're going to be able to deal with either one of those questions effectively, given the intractability that both of them have, given the resources that we're pouring into them at this point in time.

Mr. SIKORSKI. Even the one-third would be eliminated if the people in the administration have their way.

Ms. DUBESTER. I just wanted to say one thing about the solar tax credit. It is also very difficult to say when you really support the development of renewable resources at the household level, but I think one thing which is disturbing to us now, especially in the last few months, is to realize they have existed with absolutely sort of no regulation on them. There is not even the requirement that they be on the south side of a house, for example. I mean, these kinds of things I think would be basic to making sure they are effective.

Mr. MARKEY. Let me just ask this one final question. Is it possible for alternative energy resources to be developed in this country at their very earliest stages without some form of State or Federal assistance to give them the impetus to move forward before com-

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mercial viability is even a glint on the horizon for these corporations?

Ms. DUBESTER. Yes, I'm sure sometimes it is. But I think typically technology gets developed with some kind of subsidies and then usually there is sort of a technology transfer, like with solar, with tax credits for wealthier people as an inducement, and then as it gets developed and accepted, more and more people can take advantage of it. To some extent, that has happened with solar, but as has been pointed out, the solar industry will suffer if those tax credits are removed and not the others.

Mr. MARKEY. Does anybody else want to comment on that?

Mr. SIKORSKI. Can Philips comment? How do you get that into people's homes?

Mr. BRIODY. How do we get into people's homes?

Mr. SIKORSKI. Yes. How do you get those systems——

Mr. BRIODY. We don't do it very well.

Mr. SIKORSKI. I know. How is it going to be done?

Mr. BRIODY. We don't feel that we have the resources that would be required to communicate the message to not only the homeowner but even to the businessman. In many ways I have been asked over the years by even your counterparts on what would I do in your place. What I would do is have a tendency to invite, at least in the lighting business, the three major manufacturers and ask them as a first pass to eliminate the alternative choice, the inefficient choice which is being bought every day out of inertia, eliminate that choice. Don't let anybody make that choice and force them to make the right choice. That could be done. The problem is in a free enterprise environment no one manufacturer will exercise that option.

Mr. MARKEY. Yes, Miss Dubester.

Ms. DUBESTER. I just wanted to point out that I think Bloomingdale's now offers one of those light bulbs in a designer lamp which comes along with it.

Mr. MARKEY. There is no Bloomingdale's in my district, unfortunately——

Ms. DUBESTER. Nor mine.

Mr. MARKEY. Chelsea and Revere just aren't up with that.

Mr. SIKORSKI. When they get to Penny's or Sears Roebuck——

Mr. GOLDNER. I would like to make a comment. It's true that the problem that Mr. Broidy mentioned, to bring those technologies into the home when the advantage is the lifetime cycle, expenses versus initial capital investment, it is a very difficult problem. But in industry that process is much easier to be done. Energy conservation is going to very much depend on essentially the tax structure of industry. Our analyses have shown that, for instance, the Treasury I or Treasury II proposal will reduce the economic incentive to proceed with industry becoming more efficient. In fact, it will reverse the process.

To some extent that started about 10 years ago, pushing industry to become more energy efficient.

Mr. MARKEY. Than you very much. We thank all of you for your testimony here.

Mr. Goldner, did you have something in conclusion you would like to add?

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Mr. GOLDNER. I was only going to add one little thought, and that was regarding your question and your earlier statement, namely, I think that the alternative energy sources would be more competitive if we were allowed to be more competitive. That is with respect to the fact that nuclear has been subsidized for so long that we fail to remember that, and so they are reaping the benefits now, whereas the infant alternative energy sources are not.

Mr. MARKEY. If those advocates to the free enterprise system had the courage of their convictions, then Charles Darwin's theory would apply to all energy sources as we shove them out into the marketplace to compete for scarce investment dollars. But we don't really have an administration which is intellectually consistent, either in its economic or a range of other policies. So we wind up with this incredible bifurcated policy.

I am glad that you're here and alive and well, and I can tell you that you have friends in Congress. We are going to scrap as hard as we can to ensure not only that you get all that you need but to move out into the forefront of where this country should go in terms of providing indigenous energy resources that can, in fact, help us break our addiction to imported oil and other more dangerous energy sources.

We thank you all very, very much for your participation here today. With that, this hearing is adjourned. I want to thank once again the gentleman from Minnesota who has visited us and enjoys from Minnesota our warm fall days, and we thank all of you for your patience today.

With that, this hearing is adjourned.

[Whereupon, at 12:33 p.m., the subcommittee was adjourned.]

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